

BATTERY RECYCLING  
USING THE  
CX SYSTEM AT  
TONOLLI CANADA LIMITED

JANUARY 1992



Ontario

Environment  
Environnement

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TONOLLI CANADA LIMITED

Report prepared for:

Waste Management Branch  
Ontario Ministry of the Environment

Report prepared by:

Tonolli Canada Limited

JANUARY 1992



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This final report has been prepared by Tonolli Canada Limited to fulfill the obligations under the Terms of Agreement, Section 11, pertinent to the Industrial Waste Diversion Program.

The CX System was installed by Tonolli in the Mississauga facility in 1990 and started limited production in December 1990. Full production was achieved after process start-up and commissioning by April 1, 1991. The end result is an improved battery breaking and lead separation process and of significance from an environmental point of view is a dramatic reduction in liquid and solid waste and air emissions. The innovative process also enables the production of detergent-grade sodium sulphate as a valuable by-product suitable for sale.

The CX System has achieved the expected process/environmental gains listed below:

1. The separation of metallic lead from lead oxide/sulphide provides an opportunity to simply melt grids and poles to produce hard lead in a rotary furnace at lower temperatures. The paste is smelted separately after desulphurization to produce soft lead.
2. The separation of polypropylene from other casing and separator materials maximizes the value of plastic for resale. Also final disposal of ebonite, PVC and paper separators is minimized.
3. Paste desulphurization results in an approximately 85% reduction of furnace feed sulphur content. This allows a reduction of fluxing agents and a dramatic reduction in sulphur dioxide emission. The decrease in sulphur dioxide is quantified in the report "Impact of CX Process on SO<sub>2</sub> Emissions", Church & Trought Inc., August, 1991.

4. Desulphurized paste provides an approximately 15% increase in furnace productivity compared with sulphurized paste. Processing desulphurized paste requires about 10% less energy due to a reduction in furnace temperature of about 100 to 150°C.
5. Desulphurization results in a 60% reduction in solid waste (slag) and, therefore the corresponding cost associated with disposal of this material.
6. The production of sodium sulphate provides a valuable by-product suitable for sale. The CX Process which is designed to process 60,000 tonnes per year of batteries can recover 7,100 tonnes per year of sodium sulphate meeting detergent-grade specifications.
7. Because sulphuric acid drained from batteries is reused in the desulphurization process, any wastewater discharged from the plant meets Region of Peel sewer discharge criteria.

The generation of detergent-grade sodium sulphate as a by-product (item 6 above) has been achieved as expected by the CX System. Up to September, 1991, approximately 2.5 million pounds of sodium sulphate has been produced and marketed through a chemical broker (Canada Colors). During plant start-up and commissioning another 200 tonnes of sodium sulphate was recycled in the plant.

In addition to the dramatic reduction in sulphur dioxide emission to the atmosphere (item 3 above), the CX System has enabled Tonolli to reuse over 3,000 tonnes of, 18% by weight, diluted sulphuric acid in the desulphurization process and thereby divert liquid waste discharged to the Plant's sanitary sewer system.



Slag generation has been reduced by some 1,000 tonnes up to September 1991 which normally would have been disposed by landfill.

Overall the CX System has technically met process expectations, environmental gains and by-product quality specifications (together with successful marketing of the by-product) and is still a valuable addition to Tonolli's Mississauga operation. Unfortunately, economics of the process have met with less success. Downturns in both the lead and sodium markets (documented by articles in Scrap Processing and Recycling, September/October 1991, "Lead Faces Tough Times" and Chemical Marketing Reporter, April 29, 1991 "Detergent Compact Shift Makes Sulfate Outlook Grim".) have resulted in poor project economics for Tonolli's CX System. Substantially lower market prices for lead and sodium sulphate coupled with higher costs for soda ash (increased in cost by 25% for the reagent required in the CX Process) and electric power (increased by 18%, January 1, 1991) have resulted in the economics changing from positive to negative. If the above conditions remain as is or become worse, the project could become a short term (1-2 year) liability and perhaps become viable again in the longer term pending stricter controls on effluent wastewater discharge and higher landfill disposal tipping fees.

The process equipment selected for Tonolli's CX System has proved to be adequate except for a few exceptions. The original materials of construction selected for the main heat exchanger and crystallizer were 316 stainless steel. Experience now has shown that a higher quality material such as monel might be warranted in these processes due to the presence of fairly high chloride levels in the soda ash reagent used in the desulphurization process even though no visible evidence of corrosion is present after 6 months of full operation. Modifications were required in the ceramic hydrocyclone system due to fine particles plugging the system and forcing outages.

Tonolli believes that the project was appropriate and has technically performed to expectations. However, in light of our experiences, we would most likely take a different approach in several areas as follows:

1. Because the economic viability of the CX System is dependent on market prices for products such as lead and sodium sulphate, and on operating items such as electric power, soda ash reagent etc., a much firmer cost basis would have been appropriate for the above. For example, on-site generation of electric power and steam using an energy-from-waste incinerator could have enhanced project economics to balance out rising electric power costs. However this would have necessitated having a Certificate of Approval in place and would have contradicted Ontario Environment's approach to incineration based on the Minister's statement "Incineration is Inconsistent with reduction, re-use and recycling because it relies on a steady, large quantity of mixed waste. It is a superficial solution that does not attack the root of the problem; we must waste less. Incineration is an environmental sleight of hand that gives the illusion of making waste disappear when, in fact, it reappears in different and often more hazardous forms", (Reference-Civic Public Works, September, 1991).
2. Phase II of the CX System was installed in Tonolli's Mississauga facility by revamping an existing old building. This proved to be difficult and probably resulted in a higher cost than if a new building had been constructed to house Phase II. Also, because Phase II was constructed in an operating facility (i.e. adjacent to Phase I), construction was even more difficult and took longer than anticipated.
3. The original foundation/structural engineering design for the CX System was completed by Tonolli's affiliate Engitec Impianti in Milan, Italy. Due to a difference in engineering design standards between Italy and Canada, it became apparent that the design would

have to be checked by a local engineering firm to ensure that it conformed to Canadian and Ontario Standards and in effect duplicated the engineering effort. In retrospect, it would have been more efficient and less costly to do the engineering design work locally using process design parameters established by Engitec .

4. The CX System was constructed during a period of "boom" in Ontario (i.e. 1987 - 1990) and therefore the cost of the construction contractor(s) and materials was high. It might have been more prudent to defer construction until a lower construction activity period. At the same time, the quotes, estimates, advice and recommendations of Tonolli's contractors, suppliers and consultants were generally accurate.

In summary, the new CX System has performed as expected in Tonolli's Mississauga facility to improve the lead recovery process, and environmental conditions of the plant. The various equipment components of the system have been adequate. However the current market conditions for lead, sodium sulphate, soda ash, electric power, etc., have resulted in an economic liability for the CX System rather than an economic asset which was the case when the project was started in 1987. It is expected that this will continue to be the case for perhaps the next 1 - 2 years until market conditions improve and/or change.



## APPENDIX

### IMPACT OF CX PROCESS ON SO<sub>2</sub> EMISSIONS





## **IMPACT OF CX PROCESS ON SO<sub>2</sub> EMISSIONS**

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August 1991



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## **1.0 INTRODUCTION**

Tonolli Canada Limited is a lead recovery and refinery plant located in the City of Mississauga, Ontario. Approximately 80% of the feedstock for the plant comes from batteries purchased from scrap dealers and battery manufacturers within 600 km of Mississauga. Tonolli has recently installed a state-of-the-art CX battery breaking and recycling system developed by Engitec Impianti S.p.A of Milan, Italy. The CX system crushes whole undrained batteries, separates the various components, and desulphurises the battery paste. The end result is an improved battery breaking and lead separation process and of significance from an environmental point of view is a reduction in liquid and solid waste and air emissions especially of sulphur dioxide.

This report presents the results of a stack testing program performed to determine the decrease in sulphur dioxide emission.

## 2.0 PROCESS DESCRIPTION

### 2.1 General

The CX System at Tonolli's Mississauga facility is designed to process 60,000 tonnes per year of whole, automotive batteries with plastic or ebonite cases. The process is based on a wet classification of crushed batteries to separate battery components. Key process design basis for the new system are listed in Table 1.

TABLE 1  
SUMMARY OF PROCESS DESIGN BASIS

|                                                                  |                                                                      |
|------------------------------------------------------------------|----------------------------------------------------------------------|
| Batteries processed                                              | 60,000 tonnes per year                                               |
| Waste acid solution generated                                    | 9 million litres per year                                            |
| Sodium sulphate recovered                                        | 7,100 tonnes per year, product meeting detergent grade specification |
| Lead carbonate cake for smelting                                 | 24,000 tonnes per year                                               |
| Polypropylene chips                                              | 3,000 tonnes per year                                                |
| Ebonite and polyethylene separators (used for supplemental fuel) | 2,000 tonnes per year                                                |
| Metallic lead (grids/poles/connectors)                           | 16,000 tonnes per year                                               |
| Operating basis for chemical process                             | 24 hours per day, 7 days per week, 48 weeks per year                 |

Of the total charge to the battery breaking operation, the following is produced:

|               |       |
|---------------|-------|
| Paste         | 48%   |
| Grids         | 25%   |
| Polypropylene | 4.75% |
| Hard rubber   | 5.25% |
| Acids         | 17%   |



The average charge to the furnace is as follows:

|            |               |
|------------|---------------|
| Grids      | 58 tons/day   |
| Paste      | 68.5 tons/day |
| Recyclable | 20 tons/day   |

Prior to desulphurization the paste consists of:

|        |                   |
|--------|-------------------|
| 65-70% | PbO               |
| 30-35% | PbSO <sub>4</sub> |

## 2.2 Paste Desulphurization

One of the main functions of the CX system is to desulphurise the battery paste prior to its charge to the furnaces. The sulphur content in the paste is reduced from 5.5% to less than 1%.

Either sodium hydroxide or sodium carbonate may be used in the paste desulphurization process. If soda ash is used, condensate and a predetermined amount of sodium carbonate are initially charged into the reaction tanks. Paste is then pumped from the slurry feed tank to the reaction tanks and allowed to react for about 2 hours. Waste acid from the lagoons is then pumped into the reaction tank until the pH in the tank reaches 8.0. Total reaction time is a minimum of 8 hours. The rate of addition of the acid solution is controlled to limit the rate of carbon dioxide evolution.

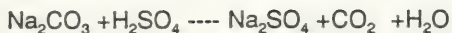
Conversion of the lead sulphate to lead carbonate in the reaction tanks is 85 -90 percent. Heat of reaction and heat from the agitator raise the temperature of the reactor batch from 35-40 C at the start to 50-55 C on batch completion. The desulphurization and

neutralization reactions are illustrated below.

Battery Paste Desulphurization:



Neutralization:



The neutralized reaction batch is then pumped to the filter press which has a 35 minute total cycle time with a 10 min load, 5 minute wash, a 5 min air blow and 15 minute paste cake cleaning from filter press plates. The filtrate is collected in a receiver tank.

The wet cake is given two water washes. The wet cake, which is comprised of lead carbonate and a small amount of unconverted lead sulphate, is collected and smelted in furnaces to recover the lead product.

The recovered lead sulphate and lead oxides are treated with soda ash to obtain lead carbonate (low sulphur content) and sodium sulphate. The two products, after separation, are processed, the former in a smelter for lead production and the latter via crystallization and drying to produce a detergent grade powdered product. One, two, or three shift operation is possible. The system is designed to recover the following products:

- a) Lead oxide paste (desulphurized) - This material with water content of about 9 percent, antimony content less than 0.5%, and sulphur content less than 1%, is smelted in three rotary furnaces to recover the lead.
- b) Lead grids and poles - These are smelted in three rotary furnaces.

- c) Polypropylene - This material is sold.
- d) Anhydrous sodium sulphate - This is recovered as a detergent grade product for resale to detergent manufacturers and glass works.

The CX system provides the following process and environmental advantages:

- a) The separation of metallic lead from lead oxide/sulphate provides an opportunity to simply melt grids and poles to produce hard lead in a rotary furnace at lower temperatures. The paste is smelted separately after desulphurization to produce soft lead.
- b) The separation of polypropylene from other casing and separator materials maximises the value of plastic for resale. Also final disposal of ebonite, PVC and paper separators is minimised.
- c) Paste desulphurization results in approximately 85 % reduction of the furnace feed sulphur content. This allows a reduction of fluxing agents and a dramatic reduction in sulphur dioxide emissions from rotary furnaces to the atmosphere.
- d) Desulphurized paste provides an approximately 15 percent increase in furnace productivity compared with sulphurized paste. Processing desulphurized paste requires about 10 percent less energy due to a reduction in furnace temperature of about 100 C to 150 C.
- e) Desulphurization results in a 60% reduction in solid waste (slag) and, therefore, reduces the corresponding cost associated with disposal of this material.

- f) The production of sodium sulphate provides a valuable (by-product) suitable for sale. The CX system which is designed to process 60,000 tonnes per year of batteries can recover 7,100 tonnes per year of sodium sulphate meeting detergent grade specifications.
- g) Because sulphuric acid drained from batteries is reused in the desulphurization process, any waste water discharged from the plant will meet future anticipated discharge criteria.

## 3.0 SULPHUR DIOXIDE EMISSIONS

### 3.1 Field measurements

Prior to the introduction of the CX system sulphur dioxide testing was conducted in Dec 1990 at the furnace baghouse where paste smelting takes place. Both continuous and integrated sampling from the main stack was done under normal operating conditions. All three furnaces were smelting paste during the sampling program. Sulphur trioxide was also measured in the integrated sampling. The paste being smelted contained approximately 5.5% sulphur.

The continuous  $\text{SO}_2$  sampling showed significant fluctuations in concentration throughout the test period depending on the activities in the furnace. The concentrations ranged from 100 ppm to 1300 ppm. (Fig.1) The average  $\text{SO}_2$  concentration during the continuous sampling was 489 ppm for an emission rate of 44.8 g/s. The average concentration of  $\text{SO}_2$  during the integrated sampling was 493 ppm for an emission rate of 45.5 g/s. The continuous and integrated results agreed within 10 % on all 3 tests. The average concentration of  $\text{SO}_3$  over the three tests was 0.7 ppm for an emission rate of 0.1 g/s. This was negligible when compared with  $\text{SO}_2$  emissions.

Testing for  $\text{SO}_2$  was repeated in July 1991 when the furnace was smelting desulphurized paste. Since continuous  $\text{SO}_2$  measurement showed good correlation with integrated sampling, only continuous monitoring was done.(Fig.2)/>

$\text{SO}_3$  emissions were not measured because previous measurements revealed that they were insignificant when compared with  $\text{SO}_2$ .

The average  $\text{SO}_2$  concentration for the entire 8 hours was 79.1 ppm for an emission rate of 7 g/s. Once again the  $\text{SO}_2$  concentrations varied significantly between the range 17.8 ppm and 255 ppm.



Details of the test program are presented in Appendix A & B.

### 3.2 Dispersion modelling

The dispersion models containing Regulation 308 were used to calculate the 1/2 hour average point of impingement concentrations (POI) of SO<sub>2</sub>. The 1/2 hour maximum point of impingement concentration of SO<sub>2</sub> during the smelting of the sulphurized paste was 438 ug/m<sup>3</sup>, based on an average emission rate of 45.5 g/s. The location of the highest concentration occurred at a distance of 690 metres from the stack.

Since the POI follows a linear relationship to the emission rate under similar operating and meteorological conditions, an emission rate of 7 g/s from the smelting of desulphurized paste would result in a POI of 67 ug/m<sup>3</sup>, a reduction of 84 %.

The maximum allowable 1/2 hour point of impingement concentration for SO<sub>2</sub> under existing regulations is 830 ug/m<sup>3</sup>. The CX system has therefore reduced the POI from 53 % to 8% of the SO<sub>2</sub> standard. The results are summarized in Table 2, and presented graphically in Figure 3.

**TABLE 2**  
**EMISSION SUMMARY**

| Paste type    | Concentration of SO <sub>2</sub> (ppm) | SO <sub>2</sub> emission rate (g/s) | % of GLC |
|---------------|----------------------------------------|-------------------------------------|----------|
| Sulphurized   | 489                                    | 45.5                                | 53       |
| Desulphurized | 79.1                                   | 7.0                                 | 8        |

## 4.0 CONCLUSIONS

1. The concentration of  $\text{SO}_2$  was reduced from an eight hour average of 490 ppm to an average of 80 ppm.
2. The rate of  $\text{SO}_2$  emissions was reduced from an eight hour average of 45 grams per second to an average of 7 grams per second, for a reduction of 84%.
3. The 1/2 hour average point of impingement concentration was reduced from 440  $\text{ug}/\text{m}^3$  to 67  $\text{ug}/\text{m}^3$ . With the new CX process, the  $\text{SO}_2$  emissions are less than 10% of the  $\text{SO}_2$  standards.



# MAIN FURNACE SO2 GAS EMISSIONS

Figure 1

DECEMBER 19, 1990

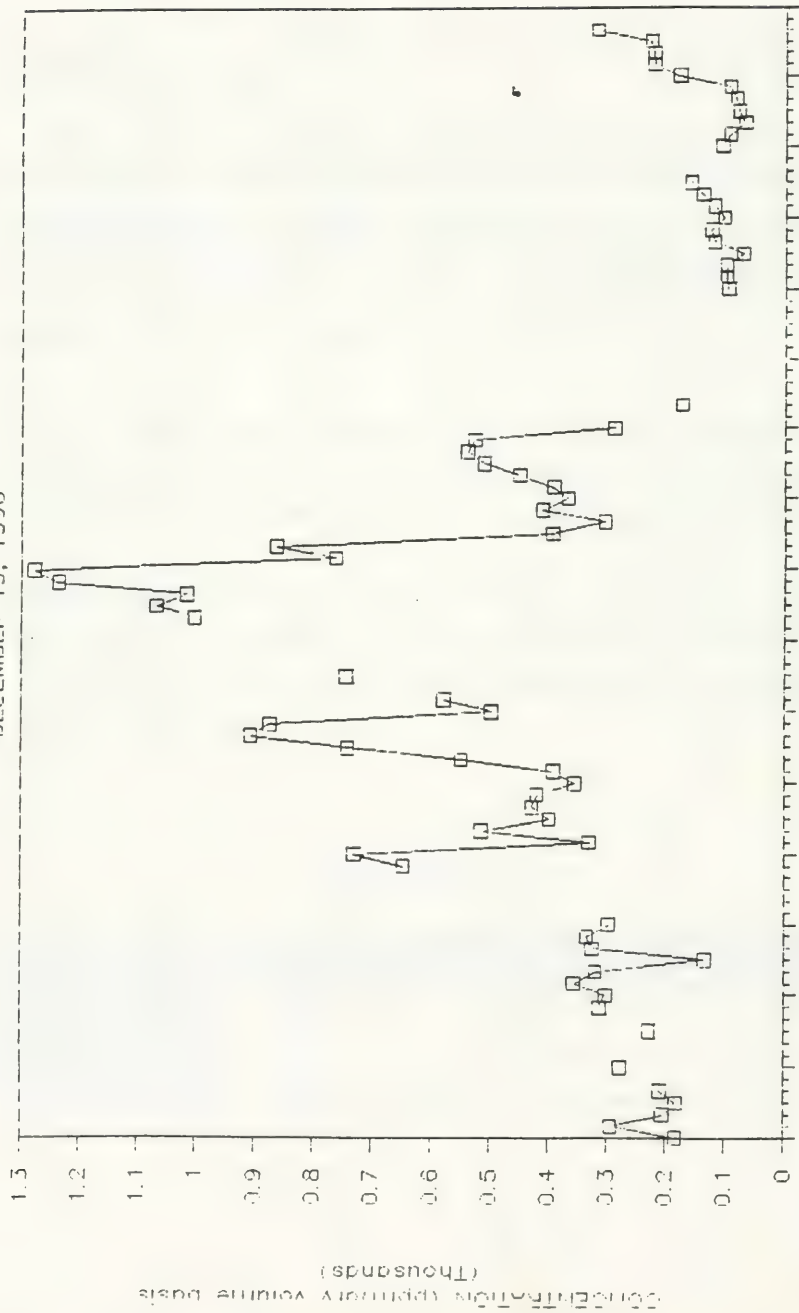
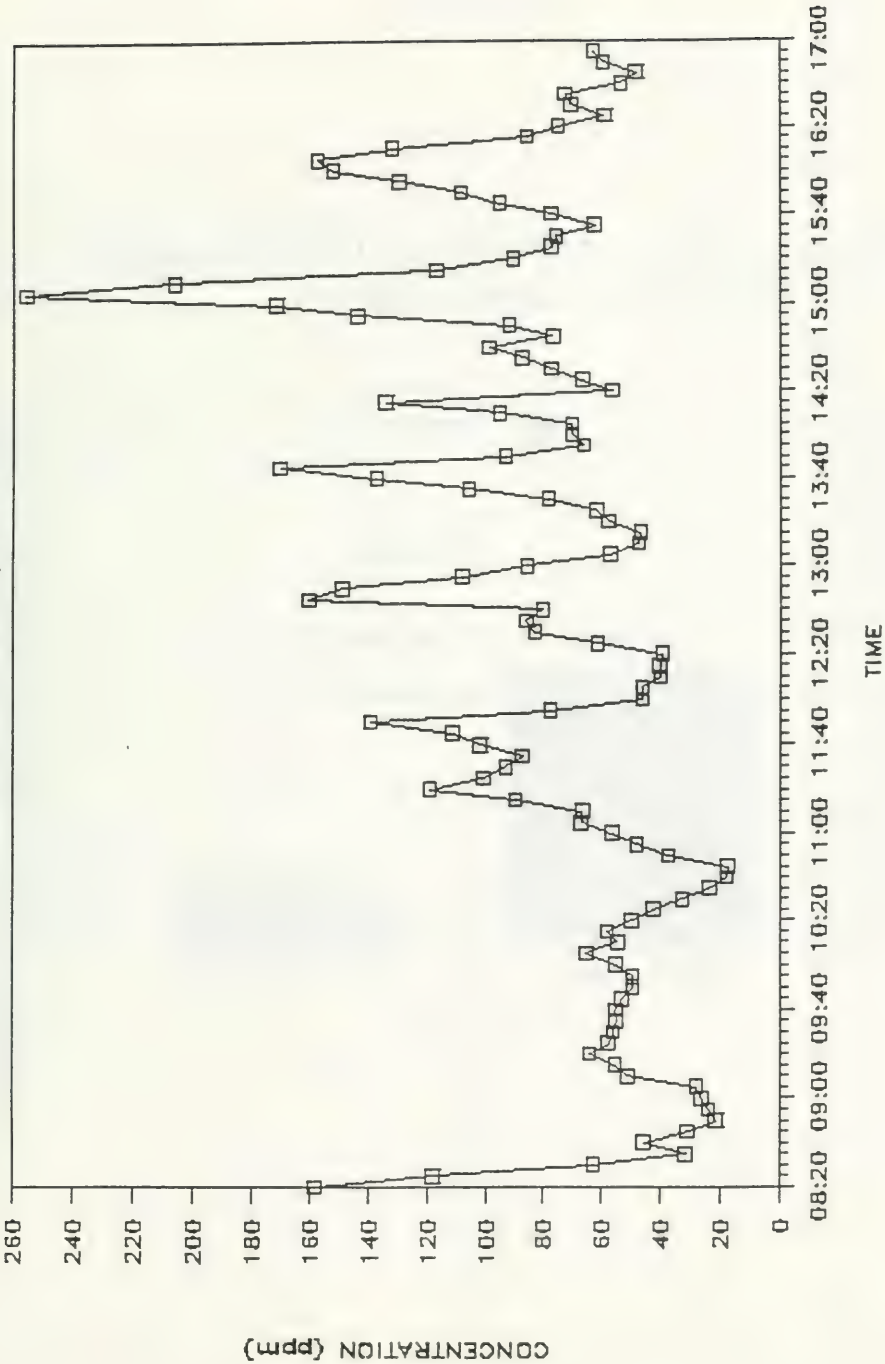


Figure 2

# MAIN FURNACE SO2 EMISSIONS

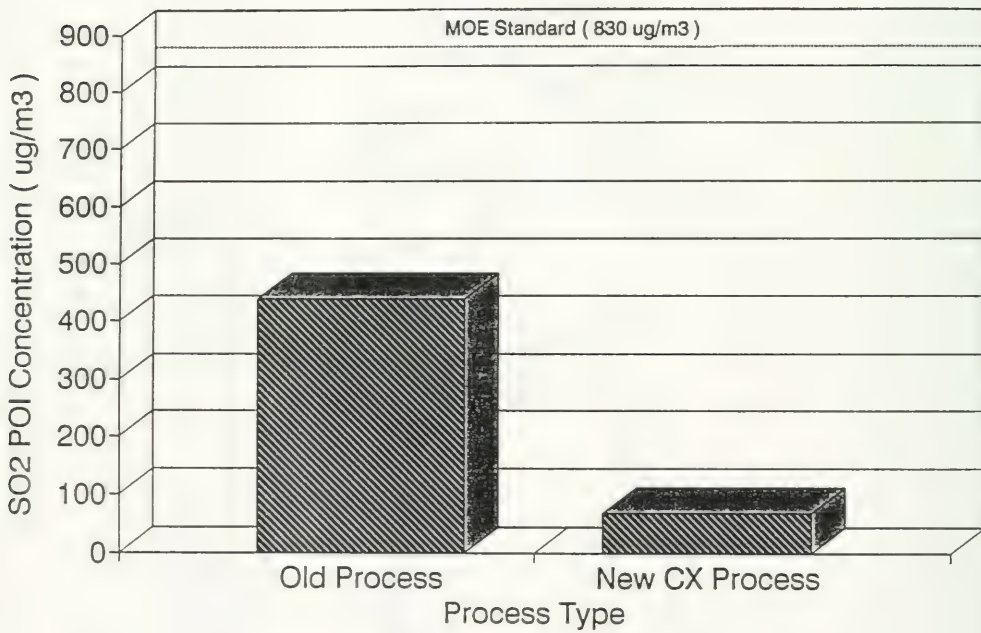
Tonolli Canada Ltd. July 3, 1991



**FIGURE 3**

# POI Impact of Tonolli's New CX Process

## SO<sub>2</sub> POI Concentrations



**Appendix A**

**December 1990**

**Test Results**



AIR TESTING SERVICES (ATS)  
178 Broadway Ave.  
Toronto, Ontario  
M4P-1V9

January 20, 1991

Church and Trought Inc.  
1315 Lawrence Ave East, Suite 104  
Don Mills, Ontario  
M3A 1C6

Attention: John Trought

Reference: SO<sub>2</sub> AND SO<sub>3</sub> TESTING AT TONOLLI CANADA LTD.  
ATS Project No. 119002P

Dear John

I am pleased to submit this report as completion of the test program at Tonolli Canada Ltd.

#### OBJECTIVE

The objective of the test program was to determine the SO<sub>2</sub> and SO<sub>3</sub> emissions from the main stack under normal operating conditions. This information will provide a comparison against data to be collected after a paste desulphurization process is installed. The information is for engineering purposes.

#### SCOPE OF WORK

- 1) Conduct continuous SO<sub>2</sub> measurements for one (1) day from the hours of 10 AM to 5 PM.
- 2) Conduct single point isokinetic SO<sub>3</sub> and SO<sub>2</sub> testing using modified EPA Method 8. Titrations were performed the same day.
- 3) Conduct temperature, velocity and moisture measurements.
- 4) Prepare letter report outlining test methods and presenting data.



## SAMPLING LOCATIONS

Sampling was performed for continuous gases on the inlet duct to the west fan. Access was through a 3/8th inch hole in the duct.

Sampling for  $\text{SO}_2$ ,  $\text{SO}_3$  and velocities were performed on the stack after the fan. The stack was 84 inches inside diameter. Sampling was performed through two 4 inch diameter ports located 90 degrees from one another approximately 80 feet from the outlet of the fan.

Isokinetic sampling was performed at 1 point on the west port approximately 50 inches into the stack.

## TEST METHODOLOGIES

### Continuous Gas Method

Stack gas was analyzed continuously for  $\text{SO}_2$  by an instrument. The instrument also measured nitrogen oxides, oxygen and carbon monoxide. The instrument used was a LAND Model 3200 portable gas analyzer.

The sample was drawn through a stainless steel probe inserted in the duct entering the fan. The sample gas was conditioned by removing particulate matter and moisture. Leakage tests were performed on the sampling system by supplying calibration gas to a tee connection at the probe and measuring the recovery of the sample gas. The recovery was 100% through the sampling system.

The instrument were calibrated at the beginning and end of the test day using certified standard calibration gas from Matheson Gas Products. There was less than 4% drift in the instrument from the beginning to the end of the test.

Data was recorded using the instrument's printer. Instantaneous values were recorded at frequent intervals through the day.

$\text{SO}_3$  and  $\text{SO}_2$  integrated testing was done using a Method 5 train according to EPA Method 8. Modifications to the method were for single point sampling. Samples were analyzed by Proctor and Redfern Lab within 8 hours of being taken.

## Stack Gas Flow Measurement

Velocity measurements were taken using a pre-calibrated "S" type pitot tube in conjunction with an inclined manometer. The equal area method, as specified by the Source Testing code, was followed to determine the volumetric flowrate. The method required dividing the duct into equal area zones. The velocities were determined within each zone and averaged. Stack static pressure and atmospheric pressure were recorded.

## Stack Temperature Measurements

Temperature measurements were made simultaneously with the velocity measurements. A commercial chromel-alumel type "K" thermocouple in conjunction with a digital temperature indicator was used.

## SCHEDULE

The test schedule was the following:

|             |                  |
|-------------|------------------|
| December 17 | Preparation      |
| December 18 | Travel<br>Set-up |
| December 19 | Test<br>pack-up  |

## RESULTS PRESENTATION

Table 1 presents a summary of the test results. Note that the continuous and integrated results agree within 10% on all tests. This is well within the expected accuracy of the methods performed. Figure 1 presents the continuous gas emission results. Note that the concentration changes through the day based on the activities in the furnaces.

The average  $\text{SO}_2$  concentration over the entire 8 hours was 394 ppm for an emission rate of 288 lb/hr. The average  $\text{SO}_3$  concentration over the three tests was 0.7 ppm for an emission rate of 0.8 lb/hr.

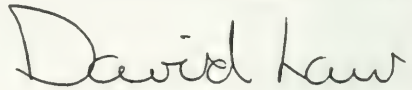
Attached can be found figures and tables presenting the detailed raw data from the testing.

We trust this report is satisfactory and it has been a pleasure working for you.

If you have any questions or comments please call me.

Yours truly,

AIR TESTING SERVICES (ATS)

A handwritten signature in cursive script that reads "David Law". The signature is written in dark ink and is positioned below the typed name "David Law".

David Law, P.Eng.,  
Vice-President

TONOLLI CANADA LTD.  
MISSISSAUGA, ONTARIO

ATS PROJECT NO: 119002  
DECEMBER 1990

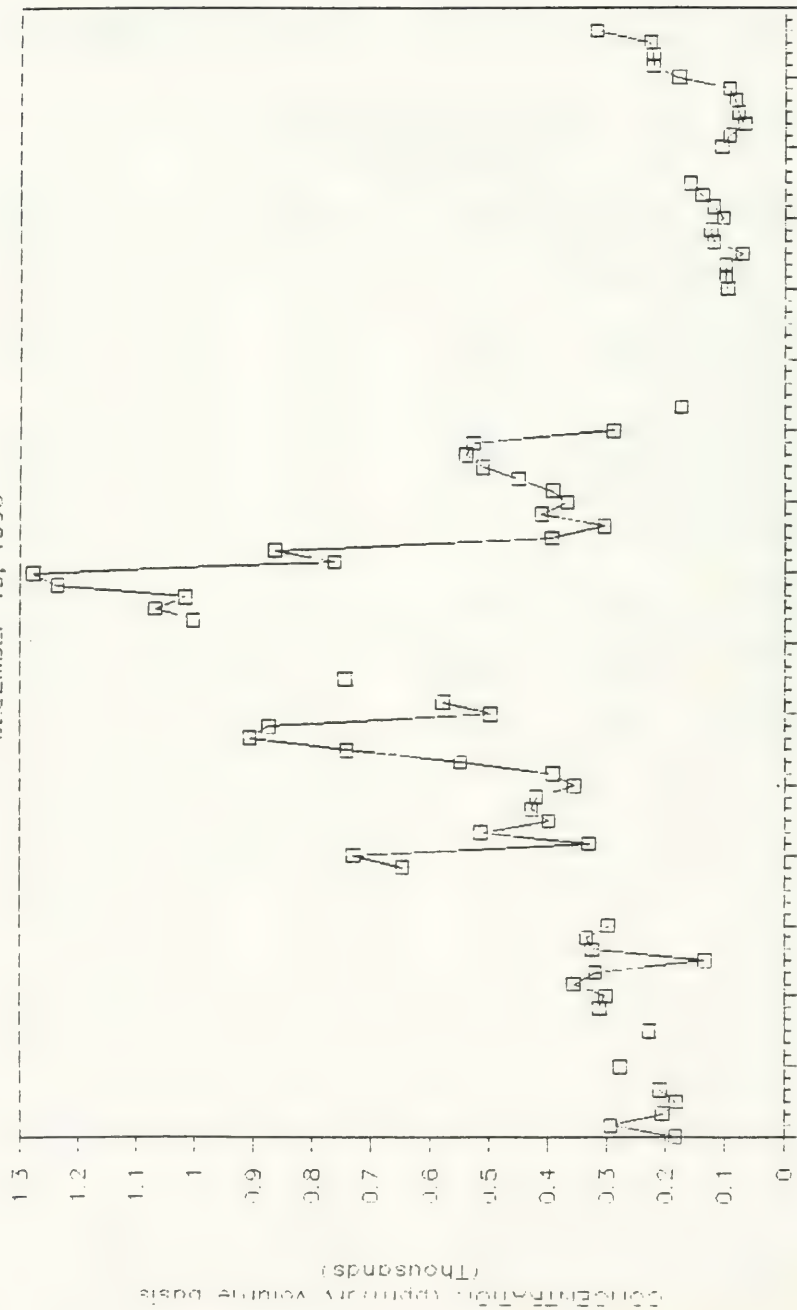
TABLE 1

MAIN FURNACE STACK  
RESULTS SUMMARY

| Emission Data         | Unit          | Test 19-1      | Test 19-2 | Test 19-3 | Average |
|-----------------------|---------------|----------------|-----------|-----------|---------|
| Continuous            |               |                |           | ↓         |         |
| SO <sub>2</sub> Conc. | ppm           | 606            | 750       | 107       | 489     |
| Emission Rate         | lb/hr         | 443            | 548       | 78        | 356     |
| Integrated            |               |                |           |           |         |
| SO <sub>2</sub> Conc. | ppm           | 665            | 697       | 118       | 493     |
| Emission Rate         | lb/hr         | 486            | 510       | 86        | 361     |
| SO <sub>3</sub> Conc. | ppm           | 1.3            | .6        | 0.3       | 0.7     |
| Emission Rate         | lb/hr         | 1.5            | 0.7       | 0.3       | 0.8     |
| Stack Gas Temperature | deg F         | 98 °           |           |           |         |
| Stack Gas Flow        | Dscfm<br>Acfm | 74600<br>78600 |           |           |         |
| Gas Velocity          | fpm           | 2040           |           |           |         |

# MAIN FURNACE SO2 GAS EMISSIONS

DECEMBER 15, 1930



TIME

December 19, 1990

ATS Project No. 119002

## MAIN FURNACE EMISSIONS

| TIME  | SO2<br>ppm | CO<br>ppm | NOX<br>ppm | O2<br>% |
|-------|------------|-----------|------------|---------|
| 09:00 | 184        | 288       | 33         | 20.7    |
| 09:05 | 294        | 260       | 50         |         |
| 09:10 | 205        | 135       | 43         |         |
| 09:15 | 183        | 80        | 44         |         |
| 09:20 | 210        | 42        | 43         |         |
| 09:25 |            |           |            |         |
| 09:30 | 278        | 381       | 36         |         |
| 09:35 |            |           |            |         |
| 09:40 |            |           |            |         |
| 09:45 | 230        | 148       | 41         |         |
| 09:50 |            |           |            |         |
| 09:55 | 314        | 64        | 28         |         |
| 10:00 | 304        | 166       | 30         |         |
| 10:05 | 357        | 131       | 26         |         |
| 10:10 | 321        | 86        | 29         |         |
| 10:15 | 135        | 122       | 21         |         |
| 10:20 | 326        | 27        | 26         |         |
| 10:25 | 335        | 22        | 32         |         |
| 10:30 | 299        | 20        | 31         |         |
| 10:35 |            |           |            |         |
| 10:40 |            |           |            |         |
| 10:45 |            |           |            |         |
| 10:50 |            |           |            |         |
| 10:55 | 647        | 49        | 26         |         |
| 11:00 | 732        | 28        | 35         |         |
| 11:05 | 332        | 238       | 23         |         |
| 11:10 | 515        | 78        | 29         |         |
| 11:15 | 400        | 134       | 26         |         |
| 11:20 | 429        | 80        | 24         |         |
| 11:25 | 421        | 79        | 23         |         |
| 11:30 | 357        | 9         | 26         |         |
| 11:35 | 393        | 7         | 27         |         |
| 11:40 | 550        | 7         | 32         |         |
| 11:45 | 743        | 7         | 42         |         |
| 11:50 | 907        | 8         | 41         |         |
| 11:55 | 875        | 85        | 22         |         |

|       |      |     |    |
|-------|------|-----|----|
| 12:00 | 498  | 280 | 18 |
| 12:05 | 579  | 235 | 25 |
| 12:10 |      |     |    |
| 12:15 | 746  | 64  | 29 |
| 12:20 |      |     |    |
| 12:25 |      |     |    |
| 12:30 |      |     |    |
| 12:35 |      |     |    |
| 12:40 | 1003 | 46  | 40 |
| 12:45 | 1068 | 66  | 47 |
| 12:50 | 1016 | 75  | 44 |
| 12:55 | 1235 | 8   | 55 |
| 13:00 | 1277 | 8   | 61 |
| 13:05 | 763  | 82  | 41 |
| 13:10 | 864  | 141 | 37 |
| 13:15 | 395  | 941 | 19 |
| 13:20 | 306  | 503 | 17 |
| 13:25 | 413  | 161 | 28 |
| 13:30 | 369  | 43  | 35 |
| 13:35 | 393  | 114 | 34 |
| 13:40 | 451  | 153 | 34 |
| 13:45 | 512  | 120 | 38 |
| 13:50 | 540  | 58  | 42 |
| 13:55 | 528  | 88  | 34 |
| 14:00 | 291  | 128 | 31 |
| 14:05 |      |     |    |
| 14:10 | 175  | 208 | 25 |
| 14:15 |      |     |    |
| 14:20 |      |     |    |
| 14:25 |      |     |    |
| 14:30 |      |     |    |
| 14:35 |      |     |    |
| 14:40 |      |     |    |
| 14:45 |      |     |    |
| 14:50 |      |     |    |
| 14:55 |      |     |    |
| 15:00 | 98   | 24  | 29 |
| 15:05 | 101  | 42  | 38 |
| 15:10 | 101  | 32  | 24 |
| 15:15 | 72   | 42  | 25 |
| 15:20 | 121  | 43  | 21 |
| 15:25 | 127  | 45  | 25 |
| 15:30 | 105  | 40  | 28 |
| 15:35 | 121  | 35  | 29 |
| 15:40 | 142  | 29  | 28 |
| 15:45 | 161  | 25  | 21 |



|         |     |     |    |
|---------|-----|-----|----|
| 15:50   |     |     |    |
| 15:55   |     |     |    |
| 16:00   | 108 | 33  | 16 |
| 16:05   | 94  | 41  | 13 |
| 16:10   | 69  | 207 | 15 |
| 16:15   | 80  | 58  | 16 |
| 16:20   | 84  | 60  | 13 |
| 16:25   | 95  | 34  | 17 |
| 16:30   | 181 | 28  | 19 |
| 16:35   | 224 | 20  | 21 |
| 16:40   | 225 | 123 | 21 |
| 16:45   | 230 | 388 | 26 |
| 16:50   | 321 | 228 | 29 |
|         |     |     |    |
| AVERAGE | 394 | 113 | 30 |

# AIR TESTING SERVICES SO2 EMISSIONS SUMMARY

CLIENT - TONOLLI CANADA LTD.  
 PROJ. # - 119002P  
 JOBSITE - MISSISSAUGA  
 LOCATION - MAIN FURNACE STACK  
 DATE - DEC 19, 1990

| TEST #                  |         |  | TEST 19-1 | TEST 19-2 | TEST 19-3 | AVERAGE |
|-------------------------|---------|--|-----------|-----------|-----------|---------|
| START TIME              |         |  | 11:28     | 12:54     | 15:03     |         |
| INITIAL METER VOLUME    | cu ft   |  | 81.85     | 106.20    | 129.40    | 105.82  |
| FINAL METER VOLUME      | cu ft   |  | 97.39     | 121.02    | 143.82    | 120.74  |
| NET METER VOLUME VM     | cu ft   |  | 15.54     | 14.82     | 14.42     | 14.93   |
| METER TEMPERATURE TM    | deg F   |  | 56        | 56        | 55        | 56      |
| METER CORR. FACTOR F    |         |  | 1.000     | 1.000     | 1.000     | 1.000   |
| ORIFICE PRESSURE DH     | in.H2O  |  | 0.9       | 0.8       | 0.8       | 0.8     |
| BAROMETRIC PRESSURE BP  | in.Hg   |  | 29.79     | 29.79     | 29.79     | 29.79   |
| STD. TEMPERATURE TR     | deg F   |  | 77        | 77        | 77        | 77      |
| REFERENCE METER VOL. VM | DScf    |  | 16.14     | 15.39     | 15.00     | 15.51   |
|                         |         |  |           |           |           |         |
| SAMPLE VOLUME VS        | mls     |  | 145       | 130       | 150       | 142     |
| ALIQOT VOLUME VA        | mls     |  | 2.00      | 2.00      | 10.00     | 4.67    |
| TITRANT VOLUME VT       | mls     |  | 34.25     | 38.18     | 27.25     | 33.23   |
| BLANK VOLUME VB         | mls     |  | 0.00      | 0.00      | 0.00      | 0.00    |
| TITRANT NORMALITY N     | N       |  | 0.0100    | 0.0100    | 0.0100    | 0.010   |
| K FOR SO2 (x10-5) K     | lb/meq  |  | 7.1       | 7.1       | 7.1       | 7.061   |
|                         |         |  |           |           |           |         |
| SO2 CONCENTRATION C1    | gr/DScf |  | 0.761     | 0.797     | 0.135     | 0.564   |
| SO2 CONCENTRATION C2    | g/DSm3  |  | 1.74      | 1.82      | 0.31      | 1.29    |
| SO2 CONCENTRATION C3    | ppm v/v |  | 665       | 697       | 118       | 493     |
|                         |         |  |           |           |           |         |
| STACK GAS FLOWRATE Q    | DScfm   |  | 74600     | 74600     | 74600     | 74600   |
|                         |         |  |           |           |           |         |
| SO2 EMISSION RATE ER1   | lb/hr   |  | 486       | 510       | 86        | 360.7   |
| SO2 EMISSION RATE ER2   | g/s     |  | 61.3      | 64.2      | 10.9      | 45.5    |

Dry Standard conditions - 77 deg F, 29.92 in.Hg  
 - 25.0 deg C, 101.325 kPa

EQUATIONS USED

$$\text{REF. METER VOLUME VMR} = \frac{\text{VM} * (\text{TR} + 460) * \text{F} * (\text{BP} + \text{DH}/13.6)}{29.92 * (\text{TM} + 460)}$$

$$\text{SO2 CONCENTRATION C1} = \frac{7000 * \text{K} * \text{N} * \text{VS} * (\text{VT} - \text{VB})}{\text{VMR} * \text{VA}}$$

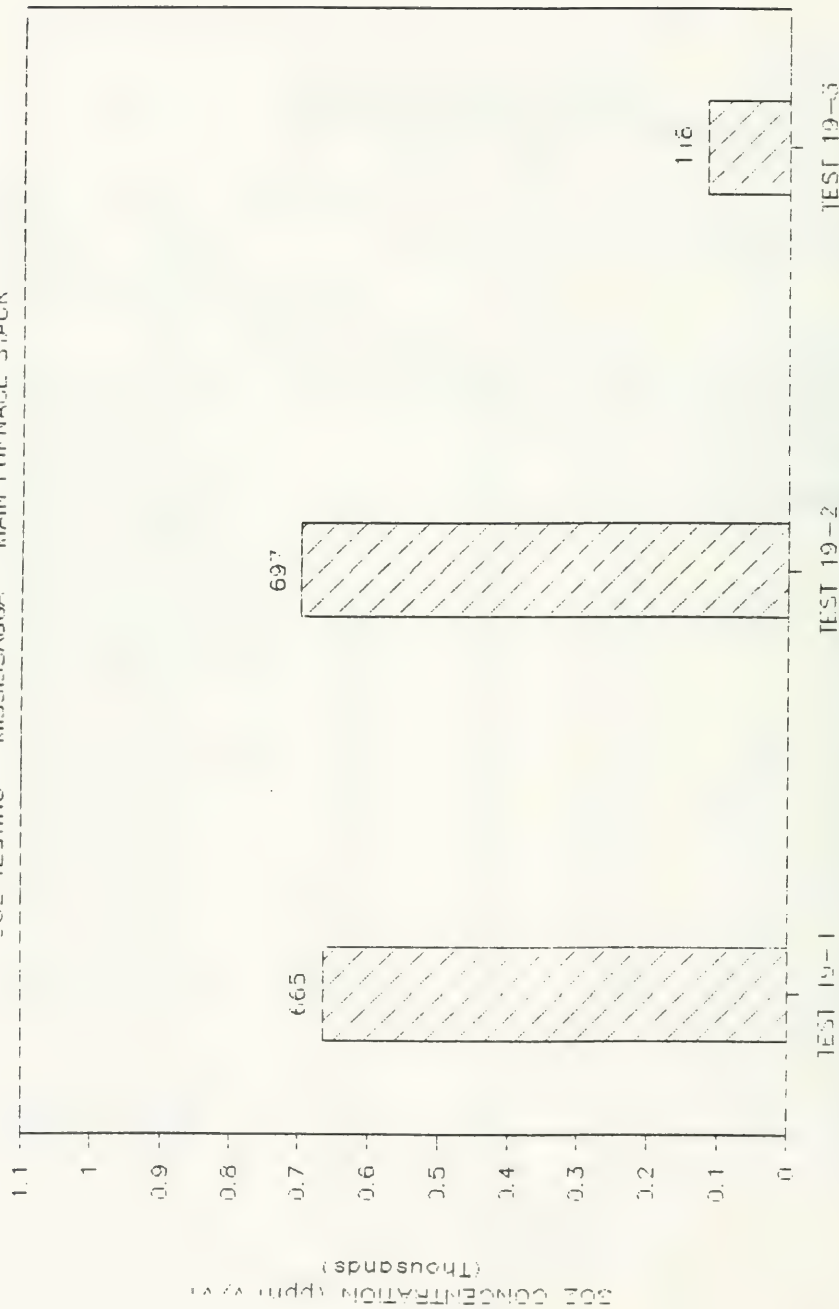
$$\text{C2} = \frac{\text{C1} * 453.6}{7000 * 0.028317} \quad \text{C3} = \frac{\text{C2} * 22.4141 * (\text{TR} + 460) * 1000000}{1000 * 64.065 * 492}$$

$$\text{SO2 EMISSION RATE ER1} = \text{C1} * \text{Q} * 60 / 7000$$

$$\text{SO2 EMISSION RATE ER2} = \text{C2} * \text{Q} * 0.028317 / 60$$

# TONOLLI CANADA LTD.

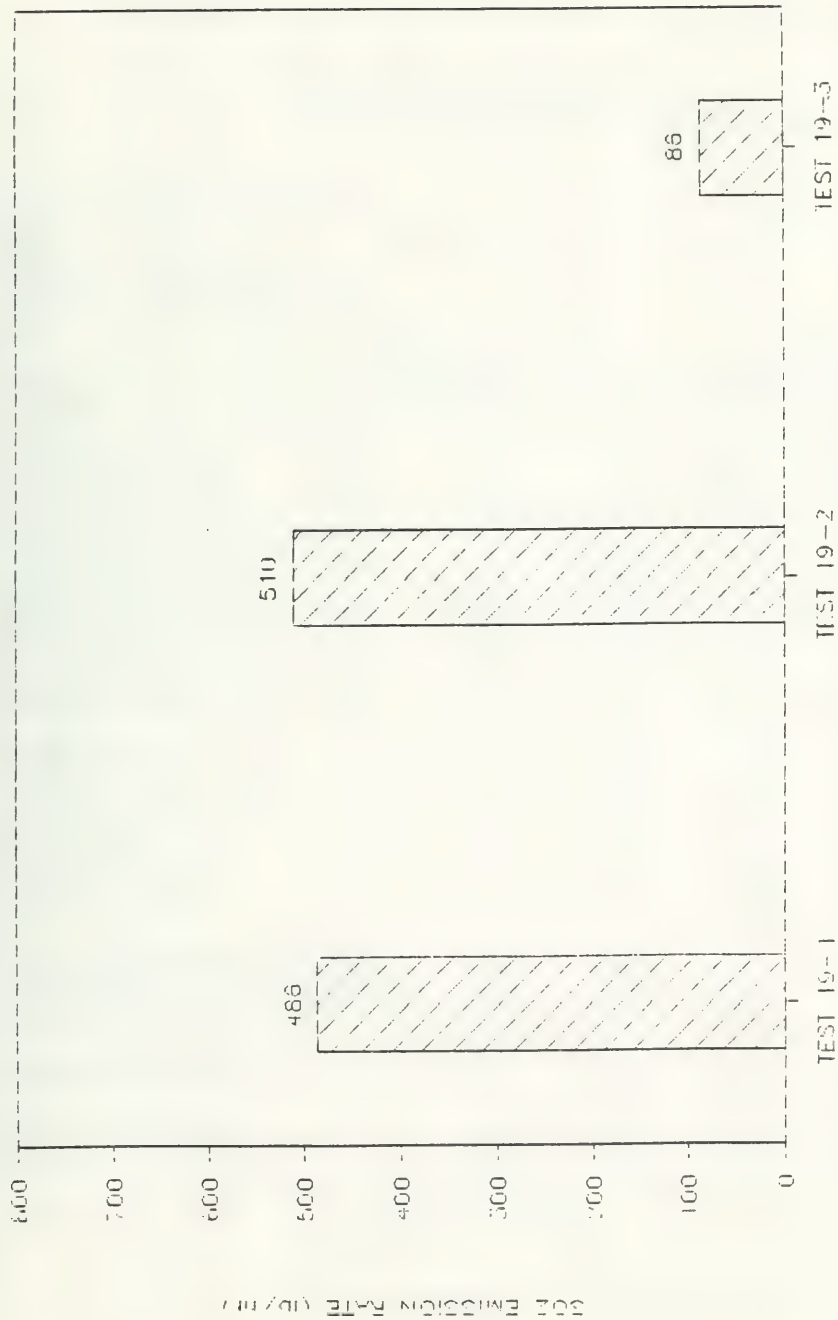
SO2 TESTING - MISSEISAUGA - MAIN FURNACE STACK



AIR TESTING SERVICES - DEC 19, 1996

# TONOLLI CANADA LTD.

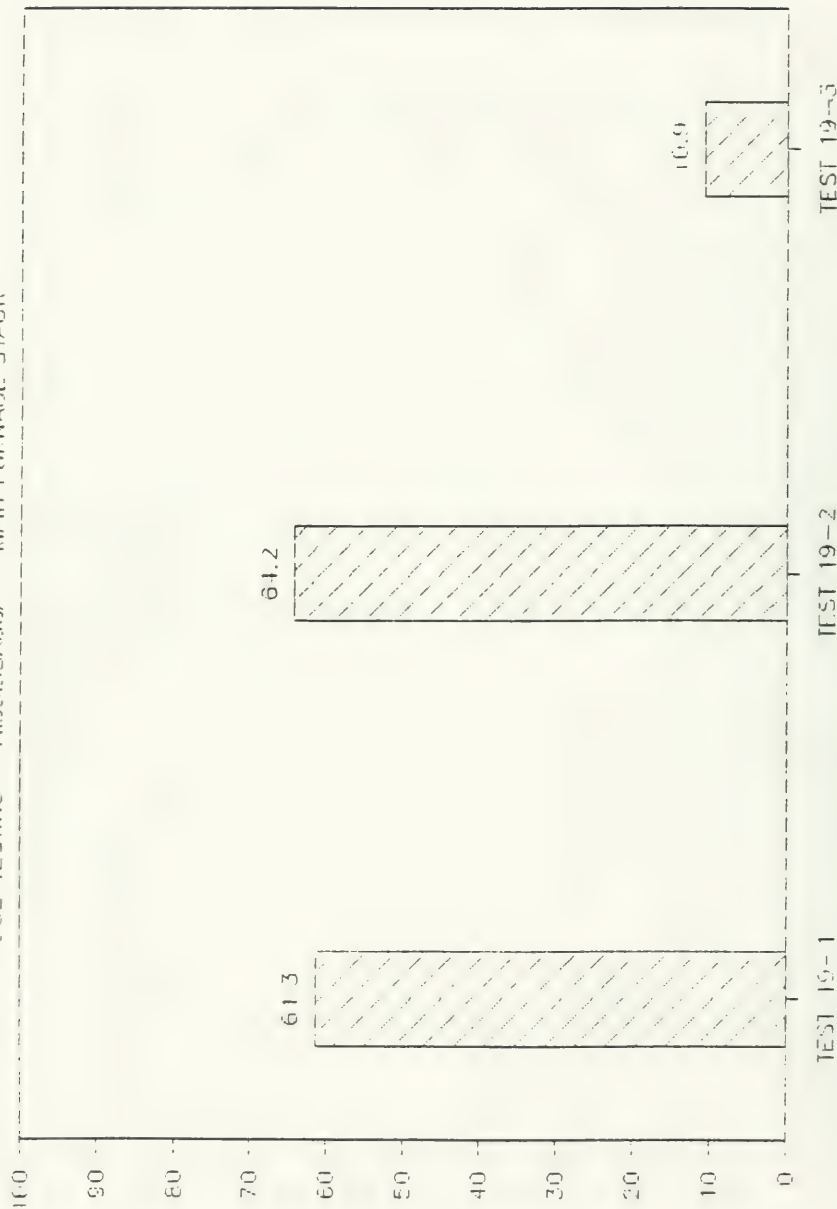
SO<sub>2</sub> TESTING - MISERIS SAUGER - MAIN FLUEGAS STACK



AIR TESTING SERVICES - DEC 19, 1990

# TONOLLI CANADA LTD.

SO2 TESTING - MISSISSAUGA - MAIN FURNACE STACK



AIR TESTING SERVICES - DEC 19, 1990

# AIR TESTING SERVICES H2SO4 EMISSIONS SUMMARY

CLIENT - TONOLLI CANADA LTD.  
 PROJ. # - 119002P  
 JOBSITE - MISSISSAUGA  
 LOCATION - MAIN FURNACE STACK  
 DATE - DEC 19, 1990

| TEST #                  |         | TEST 19-1 | TEST 19-2 | TEST 19-3 | AVERAGE |
|-------------------------|---------|-----------|-----------|-----------|---------|
| START TIME              |         | 11:26     | 12:54     | 15:03     |         |
| INITIAL METER VOLUME    | cu ft   | 81.85     | 106.20    | 129.40    | 105.82  |
| FINAL METER VOLUME      | cu ft   | 97.39     | 121.02    | 143.82    | 120.74  |
| NET METER VOLUME VM     | cu ft   | 15.54     | 14.82     | 14.42     | 14.93   |
| METER TEMPERATURE TM    | deg F   | 56        | 56        | 55        | 56      |
| METER CORR. FACTOR F    |         | 1.000     | 1.000     | 1.000     | 1.000   |
| ORIFICE PRESSURE DH     | in. H2O | 0.9       | 0.8       | 0.8       | 0.8     |
| BAROMETRIC PRESSURE BP  | in. Hg  | 29.79     | 29.79     | 29.79     | 29.79   |
| STD. TEMPERATURE TR     | deg F   | 77        | 77        | 77        | 77      |
| REFERENCE METER VOL. VM | DScf    | 16.14     | 15.39     | 15.00     | 15.51   |
| SAMPLE VOLUME VS        | mls     | 375       | 290       | 300       | 322     |
| ALIQUOT VOLUME VA       | mls     | 50.00     | 50.00     | 50.00     | 50.00   |
| TITRANT VOLUME VT       | mls     | 0.65      | 0.36      | 0.18      | 0.40    |
| BLANK VOLUME VB         | mls     | 0.00      | 0.00      | 0.00      | 0.00    |
| TITRANT NORMALITY N     | N       | 0.0100    | 0.0100    | 0.0100    | 0.010   |
| K FOR H2SO4 (x10-4) K   | lb/meq  | 1.081     | 1.081     | 1.081     | 1.081   |
| H2SO4 CONCENTRATION C1  | gr/DScf | 0.002     | 0.001     | 0.001     | 0.00    |
| H2SO4 CONCENTRATION C2  | g/DSm3  | 0.005     | 0.002     | 0.001     | 0.003   |
| SO3 CONCENTRATION C3    | ppm v/v | 1.305     | 0.586     | 0.311     | 0.734   |
| STACK GAS FLOWRATE Q    | DScfm   | 74600     | 74600     | 74600     | 74600   |
| H2SO4 EMISSION RATE ER1 | lb/hr   | 1.462     | 0.657     | 0.348     | 0.822   |
| H2SO4 EMISSION RATE ER2 | g/s     | 0.184     | 0.083     | 0.044     | 0.104   |

Dry Standard conditions - 77 deg F, 29.92 in.Hg  
 - 25.0 deg C, 101.325 kPa



# EQUATIONS USED

$$\text{REF. METER VOLUME VMR} = \frac{\text{VM} * (\text{TR} + 460) * \text{F} * (\text{BP} + \text{DH}/13.6)}{29.92 * (\text{TM} + 460)}$$

$$\text{H2SO4 CONCENTRATION C1} = \frac{7000 * \text{K} * \text{N} * \text{VS} * (\text{VT} - \text{VB})}{\text{VMR} * \text{VA}}$$

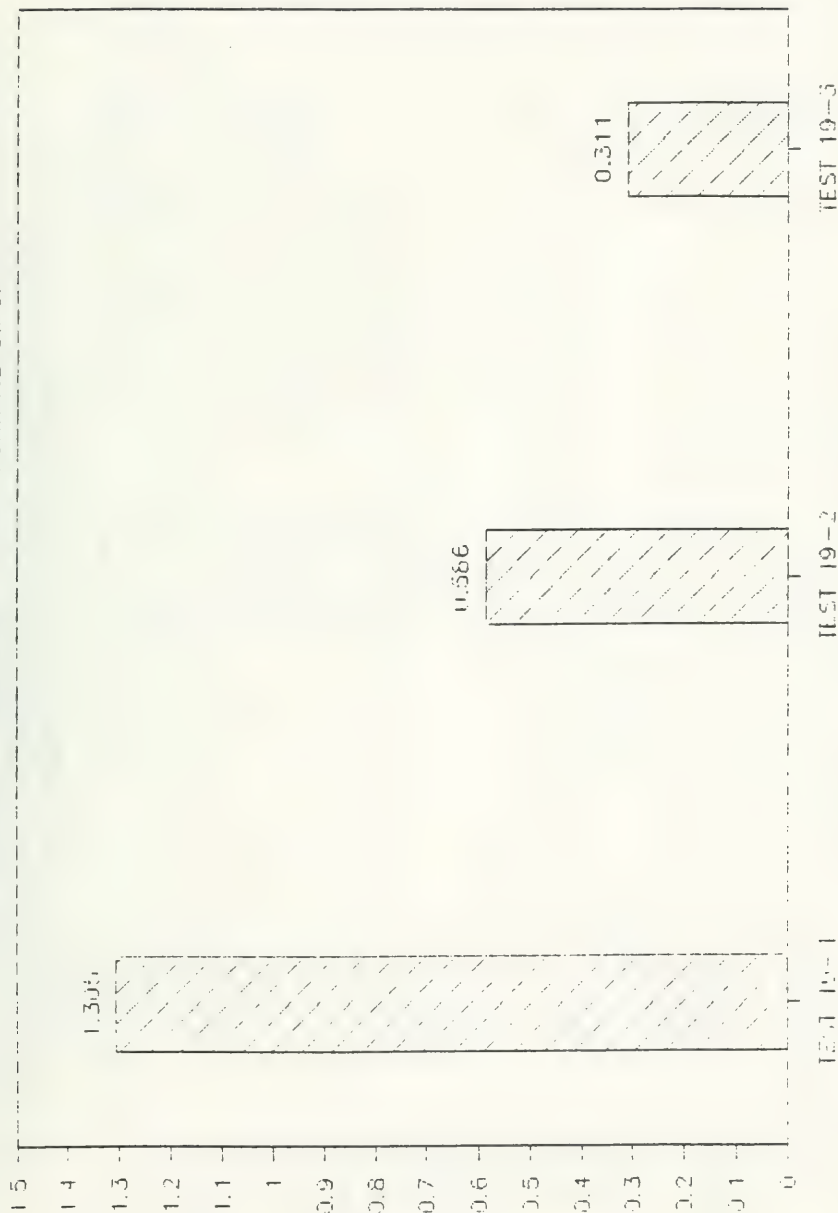
$$\text{C2} = \frac{\text{C1} * 453.6}{7000 * 0.028317} \quad \text{C3} = \frac{\text{C2} * 22.4141 * (\text{TR} + 460) * 1000000}{1000 * 98.082 * 492}$$

$$\text{H2SO4 EMISSION RATE ER1} = \text{C1} * \text{Q} * 60 / 7000$$

$$\text{H2SO4 EMISSION RATE ER2} = \text{C2} * \text{Q} * 0.028317 / 60$$

# TONOLLI CANADA LTD.

HC504 TESTING -- MISSISSAUGA -- MAIN FURNACE STACK



AIR TESTING SERVICES -- DEC 19, 1990

# TONOLLI CANADA LTD.

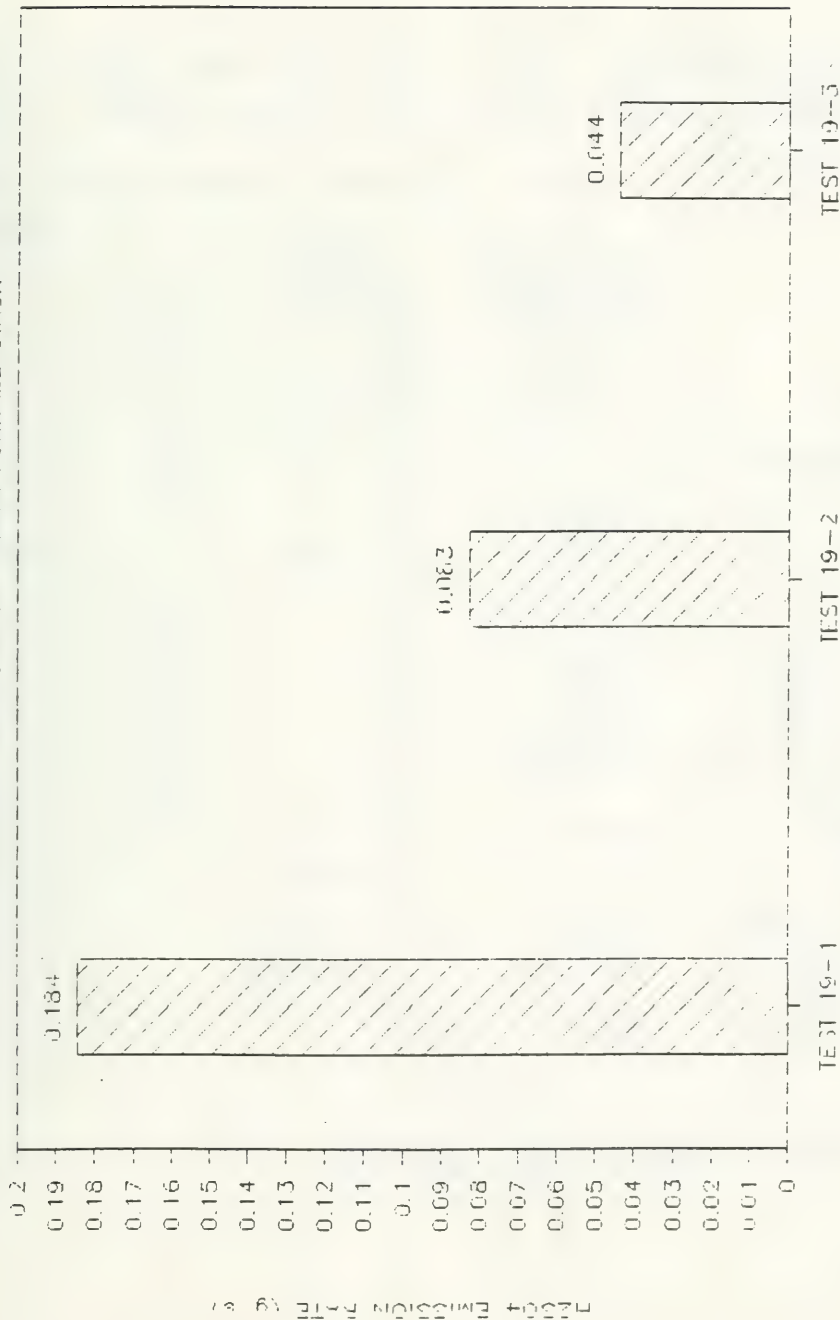
HESO+ TESTING -- MISSISSAUGA -- MAIN FURNACE STACK



AIR TESTING SERVICES -- DEC 19, 1990

# TONOLLI CANADA LTD.

H2SO4 TESTING -- MISSISSAUGA -- MAIN FURNACE STACK



AIR TESTING SERVICES -- DEC 19, 1990

CLIENT : TONOLLI CANADA LTD.  
JOBSITE : MISSISSAUGA  
REF.No. : 119002

DATE : DEC. 19 1991  
RUN : 19-1  
LOC. : MAIN FURNACE STACK

RUN TIME : 14:00 TO 14:30

|          |                             |                          |
|----------|-----------------------------|--------------------------|
| FLOWRATE | 126674 DS <sub>m</sub> 3/hr | 74558 DS <sub>c</sub> fm |
|          | 127953 WS <sub>m</sub> 3/hr | 75311 WS <sub>c</sub> fm |
|          | 133522 Am <sub>3</sub> /hr  | 78588 Ac <sub>f</sub> m  |

|          |           |            |
|----------|-----------|------------|
| VELOCITY | 10.37 m/s | 2042.1 fpm |
|----------|-----------|------------|

#### FLUE GAS CHARACTERISTICS

|          |       |
|----------|-------|
| MOISTURE | 1.0 % |
|----------|-------|

|             |            |            |
|-------------|------------|------------|
| TEMPERATURE | 36.7 deg C | 98.1 deg F |
|-------------|------------|------------|

#### GAS ANALYSIS

|                 |                    |
|-----------------|--------------------|
| O <sub>2</sub>  | 20.80 %            |
| CO <sub>2</sub> | 0.10 %             |
| CO              | 0.00 %             |
| CH <sub>4</sub> | 0.00 %             |
| MOL. WT.        | 28.96 g/gmole D.B. |

|                |        |          |
|----------------|--------|----------|
| STACK DIAMETER | 2.13 m | 84.0 in. |
|----------------|--------|----------|

|            |                      |              |
|------------|----------------------|--------------|
| STACK AREA | 3.575 m <sup>2</sup> | 38.48 sq.ft. |
|------------|----------------------|--------------|

|                     |           |             |
|---------------------|-----------|-------------|
| BAROMETRIC PRESSURE | 100.9 kPa | 29.79 in.Hg |
|---------------------|-----------|-------------|

|                 |         |                          |
|-----------------|---------|--------------------------|
| STATIC PRESSURE | 29.9 Pa | 0.12 in.H <sub>2</sub> O |
|-----------------|---------|--------------------------|

|                   |       |
|-------------------|-------|
| PITOT COEFFICIENT | 0.805 |
|-------------------|-------|

\*STANDARD CONDITIONS : METRIC 25 deg C, 101.325 kPa  
: IMPERIAL 77 deg F, 29.92 in.Hg

CLIENT : TONOLLI CANADA LTD.  
JOBSITE : MISSISSAUGA  
REF.No. : 119002

DATE : DEC. 19 1991  
RUN : 19-1  
LOC. : MAIN FURNACE STACK

| POINT | VELOCITY | PRESSURE | TEMPERATURE | DISTANCE |
|-------|----------|----------|-------------|----------|
|-------|----------|----------|-------------|----------|

TRAVERSE 1

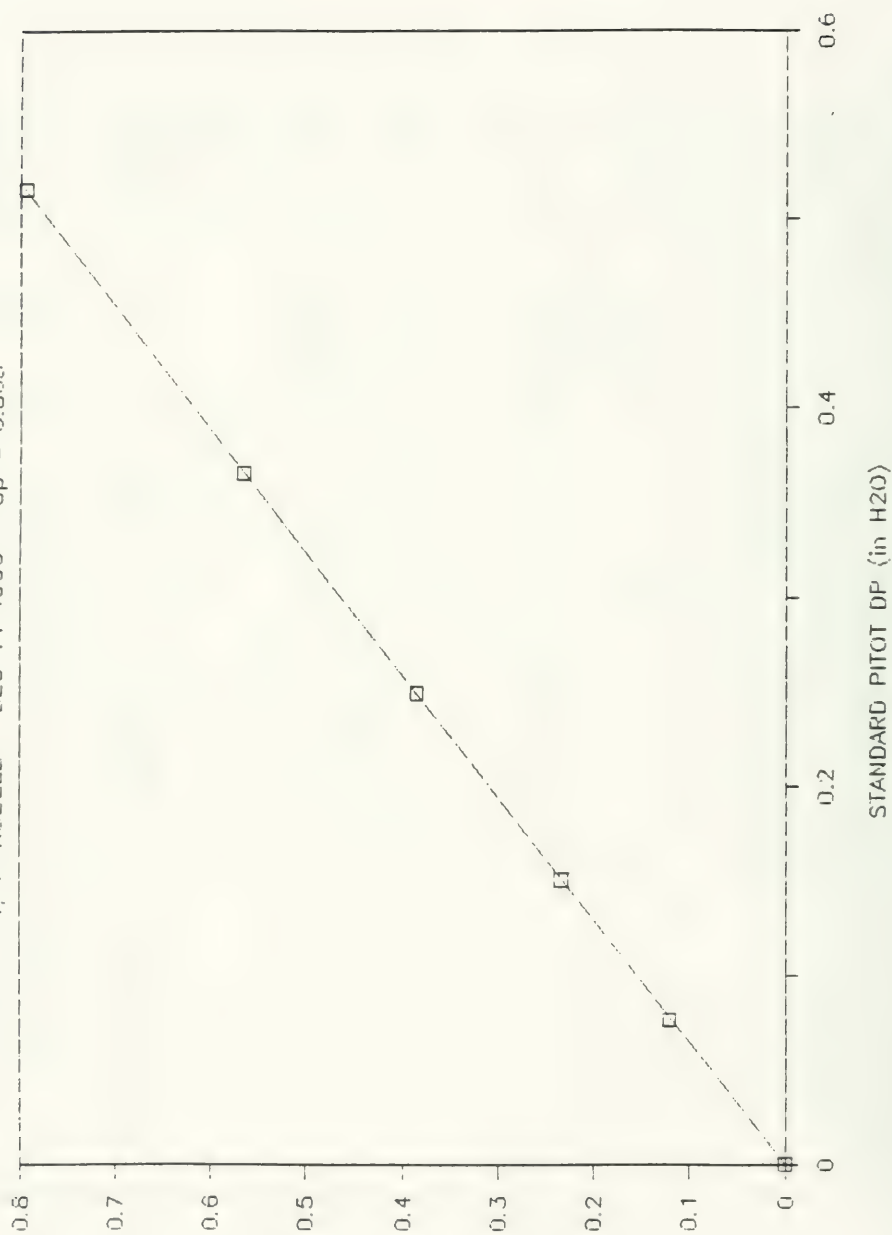
|    |      |  |     |      |
|----|------|--|-----|------|
| 1  | 0.34 |  | 97  | 2.1  |
| 2  | 0.33 |  | 100 | 6.9  |
| 3  | 0.33 |  | 100 | 12.3 |
| 4  | 0.33 |  | 100 | 19.0 |
| 5  | 0.34 |  | 100 | 28.7 |
| 6  | 0.34 |  | 99  | 55.3 |
| 7  | 0.35 |  | 99  | 65.0 |
| 8  | 0.34 |  | 99  | 71.7 |
| 9  | 0.36 |  | 99  | 77.1 |
| 10 | 0.36 |  | 99  | 81.9 |

TRAVERSE 2

|    |      |  |    |      |
|----|------|--|----|------|
| 1  | 0.45 |  | 97 | 2.1  |
| 2  | 0.47 |  | 97 | 6.9  |
| 3  | 0.45 |  | 97 | 12.3 |
| 4  | 0.43 |  | 97 | 19.0 |
| 5  | 0.44 |  | 97 | 28.7 |
| 6  | 0.41 |  | 97 | 55.3 |
| 7  | 0.41 |  | 97 | 65.0 |
| 8  | 0.37 |  | 97 | 71.7 |
| 9  | 0.37 |  | 97 | 77.1 |
| 10 | 0.37 |  | 97 | 81.9 |

# ATS 10' PROBE

1/4" NOZZLE - DEC 11 1990 -  $C_p = 0.805$





## AIR TESTING SERVICES

### PITOT TUBE CALIBRATION REPORT

PROBE ID - ATS 10' PROBE

NOZZLE - 1/4"

DATE - DEC 11 1990

| FAN SPEED | STANDARD              | PROBE                 |
|-----------|-----------------------|-----------------------|
|           | PITOT                 | PITOT                 |
|           | (in H <sub>2</sub> O) | (in H <sub>2</sub> O) |

|     |        |        |
|-----|--------|--------|
| 0   | 0.00   | 0.00   |
| 300 | 0.0765 | 0.1208 |
| 400 | 0.1509 | 0.2337 |
| 500 | 0.2496 | 0.3855 |
| 600 | 0.3658 | 0.5648 |
| 700 | 0.5152 | 0.7943 |

PITOT FACTOR  $C_p$  = 0.805



## **Appendix B**

**July 1991**

**Test Results**





AIR TESTING SERVICES INC.  
Air Emission Specialists

SO<sub>2</sub> TESTING

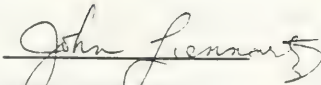
TONOLLI CANADA LTD.

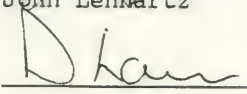
Prepared for: Church and Trought Inc.  
2 Valleybrook Drive  
Don Mills, Ontario  
M3B 2S9

Prepared by: Air Testing Services Inc.  
178 Broadway Ave. N.  
Toronto, Ontario  
M4P 1V9  
Tel. 416-487-1107  
Fax 416-488-6878

Project # 1053

July 5, 1991

  
Prepared by: John Lennartz

  
Approved by: David Law P.Eng.

July 5, 1991

Church and Trought Inc.  
2 Valleybrook Drive  
Don Mills, Ontario  
M3B 2S9

Attention:       **John Trought**

Reference:       **SO<sub>2</sub> TESTING AT TONOLLI CANADA LTD.**  
                  **ATS Project No.   1053**

Dear John

I am pleased to submit this report as completion of the test program at Tonolli Canada Ltd.

#### **OBJECTIVE**

The objective of the test program was to determine the SO<sub>2</sub> emissions from the main stack under normal operating conditions using desulphurized paste. This information will provide a comparison against data previously collected using the paste containing sulphur. The information is for engineering purposes.

#### **SCOPE OF WORK**

- 1)    Conduct continuous SO<sub>2</sub> measurements for one (1) day from the hours of 9 AM to 5 PM.
- 2)    Conduct temperature, velocity and moisture measurements.
- 3)    Prepare letter report outlining test methods and presenting data.

## **SAMPLING LOCATIONS**

Sampling for SO<sub>2</sub> was performed on the inlet duct to the west fan. Access was through a 3/8th inch hole in the duct.

Temperature and velocity readings were taken on the stack after the fan. The stack was 84 inches inside diameter. Sampling was performed through two 4 inch diameter ports located 90 degrees from one another approximately 80 feet from the outlet of the fan.

## **TEST METHODOLOGIES**

### **Continuous Gas Method**

Stack gas was analyzed continuously for SO<sub>2</sub> by an instrument. The instrument used was a WR&D 721AT SO<sub>2</sub> analyzer.

The sample was drawn through a stainless steel probe inserted in the duct entering the fan. The sample gas was conditioned by removing particulate matter and moisture. Leakage tests were performed on the sampling system by supplying calibration gas to a tee connection at the probe and measuring the recovery of the sample gas. The recovery was 100% through the sampling system.

The instrument was calibrated at the beginning and end of the test day using certified standard calibration gas from Matheson Gas Products. There was less than 1% drift in the instrument from the beginning to the end of the test.

Data was recorded using a strip chart recorder, and is presented as an average over 5 and 30 minute periods.

### **Stack Gas Flow Measurement**



Velocity measurements were taken using a pre-calibrated "S" type pitot tube in conjunction with a magnehelic. The equal area method, as specified by the Source Testing code, was followed to determine the volumetric flowrate. The method required dividing the duct into equal area zones. The velocities were determined within each zone and averaged. Stack static pressure and atmospheric pressure were recorded.

### **Stack Temperature Measurements**

Temperature measurements were made simultaneously with the velocity measurements. A commercial chromel-alumel type "K" thermocouple in conjunction with a digital temperature indicator was used.

### **SCHEDULE**

The test schedule was the following:

|        |                                 |
|--------|---------------------------------|
| July 2 | Preparation<br>Travel<br>Set-up |
| July 3 | Test<br>Pack-up                 |

### **RESULTS PRESENTATION**

Table 1 presents a summary of the test results. Figure 1 presents the continuous gas emission results. Note that the concentration changes through the day based on the activities in the furnaces. Figure 2 presents the emissions on half hour averages.

The average SO<sub>2</sub> concentration over the entire 8 hours was 79.1 ppm for an emission rate of 55.6 lb/hr.

Attached can be found figures and tables presenting the detailed raw data from the testing.

We trust this report is satisfactory and it has been a

pleasure working for you.

If you have any questions or comments please call me.

Yours truly,

AIR TESTING SERVICES (ATS)

per John Jernatt

David Law, P.Eng.,  
Vice-President



Church and Trought, Inc.  
July 1991

Air Testing Services  
Project # 1053

TABLE 1

MAIN FURNACE STACK  
RESULTS SUMMARY

| Emission<br>Data         | Unit          | Test<br>3-1    |
|--------------------------|---------------|----------------|
| Average                  |               |                |
| SO <sub>2</sub> Conc.    | ppm           | 79.1           |
| Emission Rate            | lb/hr         | 54.6           |
| Stack Gas<br>Temperature | deg F         | 158.6          |
| Stack Gas<br>Flow        | Dscfm<br>Acfm | 70500<br>84600 |
| Gas Velocity             | fpm           | 2200           |

AIR TESTING SERVICES INC.

CLIENT: TONOLLI PROJECT 1053  
 DATE: JULY 3, 1991  
 LOCATION: MAIN STACK (BAGHOUSE OUTLET)

| TIME  | SO2 (ppm) | HALF HOUR<br>AVERAGE |
|-------|-----------|----------------------|
| 08:20 | 158.0     |                      |
| 08:25 | 118.0     |                      |
| 08:30 | 63.0      |                      |
| 08:35 | 31.8      |                      |
| 08:40 | 45.9      |                      |
| 08:45 | 31.2      |                      |
| 08:50 | 21.8      | 67.1                 |
| 08:55 | 24.4      |                      |
| 09:00 | 26.7      |                      |
| 09:05 | 28.3      |                      |
| 09:10 | 51.4      |                      |
| 09:15 | 55.7      |                      |
| 09:20 | 64.3      | 38.9                 |
| 09:25 | 58.0      |                      |
| 09:30 | 56.4      |                      |
| 09:35 | 55.2      |                      |
| 09:40 | 55.4      |                      |
| 09:45 | 53.1      |                      |
| 09:50 | 49.5      | 56.0                 |
| 09:55 | 49.7      |                      |
| 10:00 | 55.2      |                      |
| 10:05 | 65.4      |                      |
| 10:10 | 54.8      |                      |
| 10:15 | 58.3      |                      |
| 10:20 | 50.0      | 54.7                 |
| 10:25 | 42.8      |                      |
| 10:30 | 32.8      |                      |
| 10:35 | 24.1      |                      |
| 10:40 | 18.2      |                      |
| 10:45 | 17.8      |                      |
| 10:50 | 37.7      | 31.9                 |
| 10:55 | 48.2      |                      |
| 11:00 | 56.8      |                      |
| 11:05 | 67.4      |                      |
| 11:10 | 66.8      |                      |

## AIR TESTING SERVICES INC.

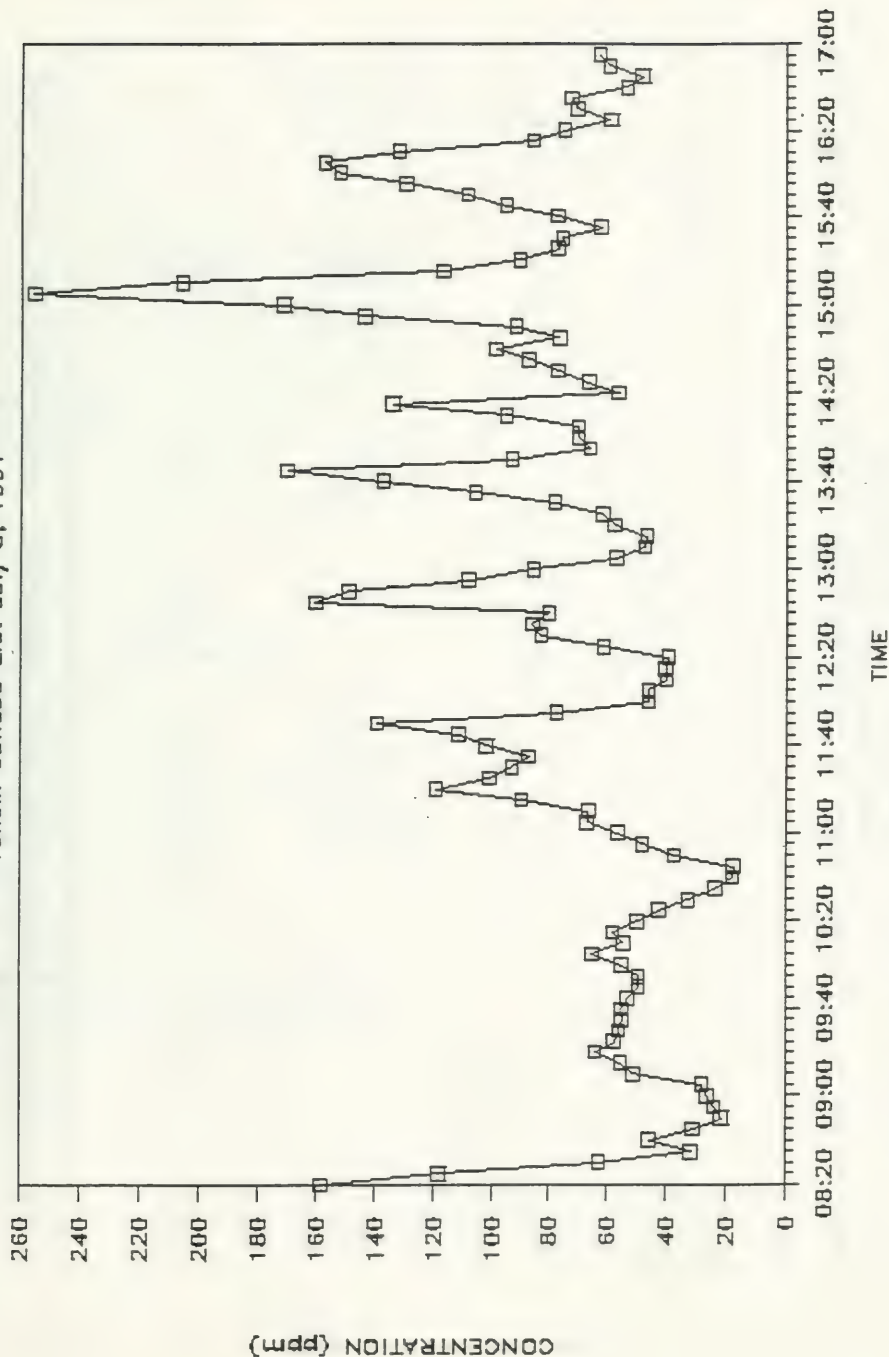
| TIME  | SO2 (ppm) | HALF HOUR<br>AVERAGE |
|-------|-----------|----------------------|
| 11:15 | 89.9      | 60.7                 |
| 11:20 | 119.0     |                      |
| 11:25 | 100.8     |                      |
| 11:30 | 93.1      |                      |
| 11:35 | 87.4      |                      |
| 11:40 | 102.0     | 107.5                |
| 11:45 | 111.3     |                      |
| 11:50 | 139.2     |                      |
| 11:55 | 77.7      |                      |
| 12:00 | 46.5      |                      |
| 12:05 | 46.3      | 61.5                 |
| 12:10 | 40.1      |                      |
| 12:15 | 40.6      |                      |
| 12:20 | 39.8      |                      |
| 12:25 | -61.8     |                      |
| 12:30 | 82.9      | 94.3                 |
| 12:35 | 86.2      |                      |
| 12:40 | 80.3      |                      |
| 12:45 | 160.2     |                      |
| 12:50 | 148.7     |                      |
| 12:55 | 107.9     | 78.9                 |
| 13:00 | 85.8      |                      |
| 13:05 | 57.4      |                      |
| 13:10 | 47.6      |                      |
| 13:15 | 46.9      |                      |
| 13:20 | 57.8      | 100.6                |
| 13:25 | 62.1      |                      |
| 13:30 | 78.5      |                      |
| 13:35 | 105.6     |                      |
| 13:40 | 137.2     |                      |
| 13:45 | 170.0     | 83.7                 |
| 13:50 | 93.0      |                      |
| 13:55 | 66.4      |                      |
| 14:00 | 70.4      |                      |
| 14:05 | 70.4      |                      |
| 14:10 | 95.1      | 83.7                 |
| 14:15 | 134.0     |                      |
| 14:20 | 56.7      |                      |

## AIR TESTING SERVICES INC.

| TIME  | SO2 (ppm) | HALF HOUR<br>AVERAGE |
|-------|-----------|----------------------|
| 14:25 | 66.8      |                      |
| 14:30 | 77.3      |                      |
| 14:35 | 87.4      |                      |
| 14:40 | 98.6      |                      |
| 14:45 | 76.9      |                      |
| 14:50 | 91.8      | 69.4                 |
| 14:55 | 143.5     |                      |
| 15:00 | 171.4     |                      |
| 15:05 | 255.8     |                      |
| 15:10 | 205.8     |                      |
| 15:15 | 116.9     |                      |
| 15:20 | 90.2      | 153.6                |
| 15:25 | 77.3      |                      |
| 15:30 | 75.8      |                      |
| 15:35 | 62.7      |                      |
| 15:40 | 77.3      |                      |
| 15:45 | 95.1      |                      |
| 15:50 | 108.4     | 83.8                 |
| 15:55 | 129.3     |                      |
| 16:00 | 151.9     |                      |
| 16:05 | 157.0     |                      |
| 16:10 | 131.9     |                      |
| 16:15 | 85.8      |                      |
| 16:20 | 75.0      | 119.9                |
| 16:25 | 59.5      |                      |
| 16:30 | 70.9      |                      |
| 16:35 | 72.6      |                      |
| 16:40 | 53.6      |                      |
| 16:45 | 48.5      |                      |
| 16:50 | 59.6      | 62.8                 |
| 16:55 | 63.1      |                      |
| 17:00 |           |                      |

# MAIN FURNACE SO2 EMISSIONS

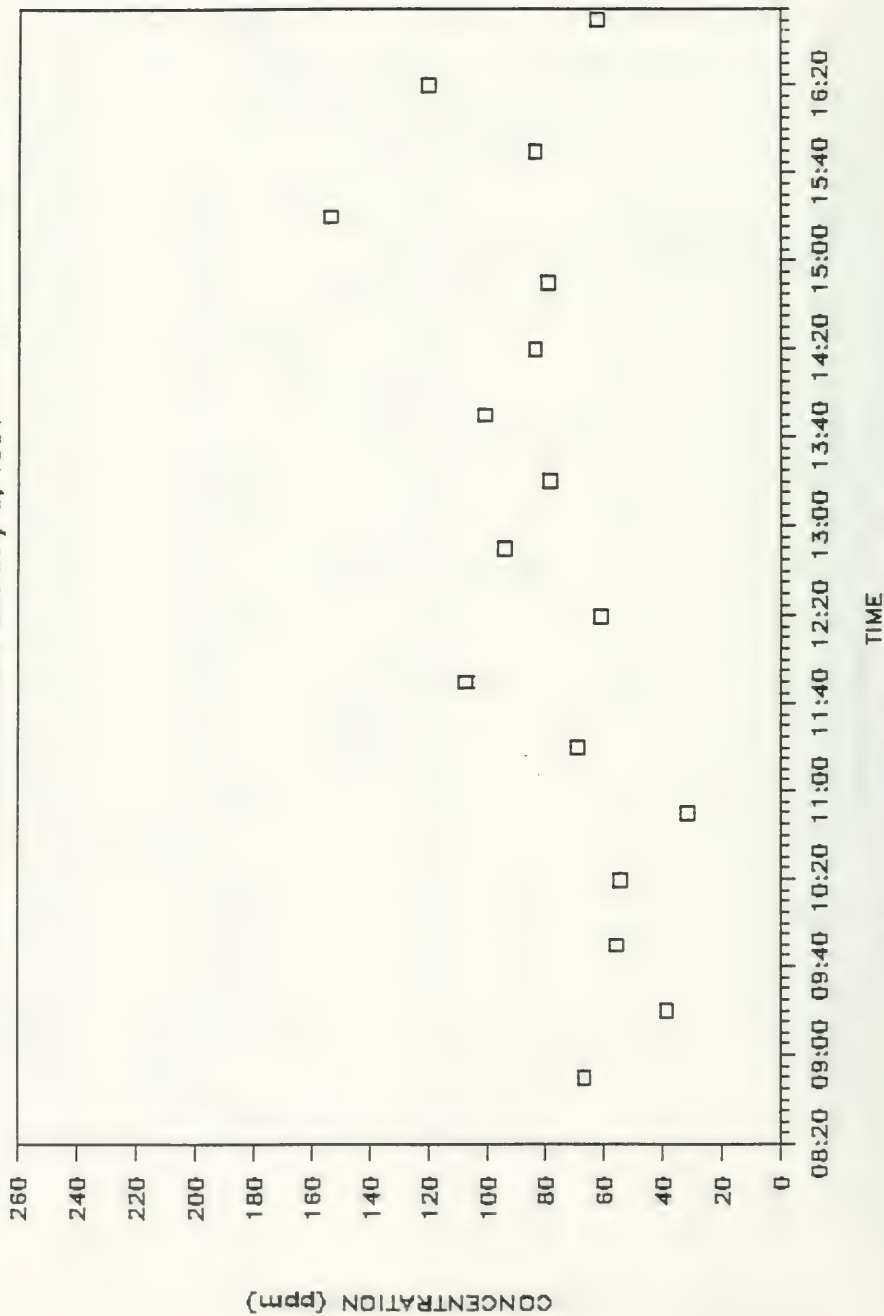
Tonolli Canada Ltd. July 3, 1991





# MAIN STACK SO2 EMISSIONS: 30 MIN. AVGS

Tonolli Canada Ltd. July 3, 1991



CLIENT : CTI/TOWOLL  
JOBSITE : MISSISSAUGA  
REF.No. : 1007-3

DATE : JULY 3 1991  
RUN : 3-1A  
LOC. : MAINSTACK (EXIT OF BAGHOUSE)

RUN TIME : 11:10 TO 11:30

|          |                             |             |
|----------|-----------------------------|-------------|
| FLOWRATE | 122400 DSm <sup>3</sup> /hr | 72042 DScfm |
|          | 127500 Wsm <sup>3</sup> /hr | 75044 Wscfm |
|          | 145912 Am <sup>3</sup> /hr  | 85881 Acfm  |

|          |           |            |
|----------|-----------|------------|
| VELOCITY | 11.34 m/s | 2231.6 fpm |
|----------|-----------|------------|

FLUE GAS CHARACTERISTICS

|             |            |             |
|-------------|------------|-------------|
| MOISTURE    | 4.0 %      |             |
| TEMPERATURE | 67.6 deg C | 153.7 deg F |

GAS ANALYSIS

|          |                    |
|----------|--------------------|
| O2       | 20.90 %            |
| CO2      | 0.00 %             |
| CO       | 0.00 %             |
| CH4      | 0.00 %             |
| MOL. WT. | 28.95 g/gmole D.B. |

|                     |                      |              |
|---------------------|----------------------|--------------|
| STACK DIAMETER      | 2.13 m               | 84.0 in.     |
| STACK AREA          | 3.575 m <sup>2</sup> | 38.48 sq.ft. |
| BAROMETRIC PRESSURE | 101.1 kPa            | 29.86 in.Hg  |
| STATIC PRESSURE     | 54.8 Pa              | 0.22 in.H2O  |
| PITOT COEFFICIENT   | 0.805                |              |

\*STANDARD CONDITIONS : METRIC 25 deg C, 101.325 kPa  
: IMPERIAL 77 deg F, 29.92 in.Hg

CLIENT : CTI/TONOLLI  
JOBSITE : MISSISSAUGA  
REF.No. : 1007-3

DATE : JULY 3 1991  
RUN : 3-1A  
LOC. : MAINSTACK (EXIT OF BAGHOUSE)

| POINT | VELOCITY | PRESSURE | TEMPERATURE | DISTANCE |
|-------|----------|----------|-------------|----------|
|-------|----------|----------|-------------|----------|

TRAVERSE 1

|    |      |  |     |      |
|----|------|--|-----|------|
| 1  | 0.33 |  | 151 | 2.1  |
| 2  | 0.43 |  | 153 | 6.9  |
| 3  | 0.43 |  | 154 | 12.3 |
| 4  | 0.44 |  | 155 | 19.0 |
| 5  | 0.44 |  | 156 | 28.7 |
| 6  | 0.40 |  | 156 | 55.3 |
| 7  | 0.39 |  | 156 | 65.0 |
| 8  | 0.39 |  | 157 | 71.7 |
| 9  | 0.37 |  | 157 | 77.1 |
| 10 | 0.36 |  | 157 | 81.9 |

TRAVERSE 2

|    |      |  |     |      |
|----|------|--|-----|------|
| 1  | 0.28 |  | 146 | 2.1  |
| 2  | 0.38 |  | 148 | 6.9  |
| 3  | 0.40 |  | 148 | 12.3 |
| 4  | 0.40 |  | 150 | 19.0 |
| 5  | 0.42 |  | 152 | 28.7 |
| 6  | 0.43 |  | 154 | 55.3 |
| 7  | 0.45 |  | 155 | 65.0 |
| 8  | 0.47 |  | 157 | 71.7 |
| 9  | 0.50 |  | 156 | 77.1 |
| 10 | 0.46 |  | 155 | 81.9 |

CLIENT : CTI/TOMOLLI  
JOBSITE : MISSISSAUGA  
REF.No. : 1007-3

DATE : JULY 3 1991  
RUN : 3-1B  
LOC. : MAIN STACK (EXIT OF BAGHOUSE)

RUN TIME : 14:05 TO 14:30

|          |                             |             |
|----------|-----------------------------|-------------|
| FLOWRATE | 117030 DSm <sup>3</sup> /hr | 68882 DScfm |
|          | 121906 WSm <sup>3</sup> /hr | 71752 WScfm |
|          | 141727 Am <sup>3</sup> /hr  | 83418 Acfm  |
| VELOCITY | 11.01 m/s                   | 2167.6 fpm  |

#### FLUE GAS CHARACTERISTICS

|             |            |             |
|-------------|------------|-------------|
| MOISTURE    | 4.0 %      |             |
| TEMPERATURE | 73.0 deg C | 163.4 deg F |

#### GAS ANALYSIS

|                 |                    |
|-----------------|--------------------|
| O <sub>2</sub>  | 20.90 %            |
| CO <sub>2</sub> | 0.00 %             |
| CO              | 0.00 %             |
| CH <sub>4</sub> | 0.00 %             |
| MOL. WT.        | 28.95 g/gmole D.B. |

|                     |                      |                          |
|---------------------|----------------------|--------------------------|
| STACK DIAMETER      | 2.13 m               | 84.0 in.                 |
| STACK AREA          | 3.575 m <sup>2</sup> | 38.48 sq.ft.             |
| BAROMETRIC PRESSURE | 101.1 kPa            | 29.86 in.Hg              |
| STATIC PRESSURE     | 54.8 Pa              | 0.22 in.H <sub>2</sub> O |
| PITOT COEFFICIENT   | 0.805                |                          |

\*STANDARD CONDITIONS : METRIC 25 deg C, 101.325 kPa  
: IMPERIAL 77 deg F, 29.92 in.Hg

CLIENT : CTI/TONOLLI  
JOBSITE : MISSISSAUGA  
REF.No. : 1007-3

DATE : JULY 3 1991  
RUN : 3-1B  
LOC. : MAIN STACK (EXIT OF BAGHOUSE)

| POINT | VELOCITY | PRESSURE | TEMPERATURE | DISTANCE |
|-------|----------|----------|-------------|----------|
|-------|----------|----------|-------------|----------|

TRAVERSE 1

|    |      |  |     |      |
|----|------|--|-----|------|
| 1  | 0.30 |  | 159 | 2.1  |
| 2  | 0.34 |  | 160 | 6.9  |
| 3  | 0.36 |  | 161 | 12.3 |
| 4  | 0.36 |  | 163 | 19.0 |
| 5  | 0.36 |  | 164 | 28.7 |
| 6  | 0.43 |  | 165 | 55.3 |
| 7  | 0.44 |  | 165 | 65.0 |
| 8  | 0.43 |  | 166 | 71.7 |
| 9  | 0.45 |  | 166 | 77.1 |
| 10 | 0.34 |  | 166 | 81.9 |

TRAVERSE 2

|    |      |  |     |      |
|----|------|--|-----|------|
| 1  | 0.33 |  | 156 | 2.1  |
| 2  | 0.39 |  | 159 | 6.9  |
| 3  | 0.41 |  | 161 | 12.3 |
| 4  | 0.41 |  | 163 | 19.0 |
| 5  | 0.41 |  | 166 | 28.7 |
| 6  | 0.37 |  | 165 | 55.3 |
| 7  | 0.37 |  | 167 | 65.0 |
| 8  | 0.37 |  | 166 | 71.7 |
| 9  | 0.38 |  | 165 | 77.1 |
| 10 | 0.33 |  | 165 | 81.9 |

AIR TESTING SERVICES, INC.

NOZZLE CALIBRATION SUMMARY

|       | DIAMETER<br>(decimal) | DIAMETER<br>(fraction) | BALSTON<br>PROBE | 5' PROBE<br>METHOD 5 | 10' PROBE<br>METHOD 5 |
|-------|-----------------------|------------------------|------------------|----------------------|-----------------------|
|       |                       |                        | 3/11/91          | 12/11/90             | 12/11/90              |
|       | 0.177                 | 3/16                   | 0.799            | 0.815                | 0.810                 |
|       | 0.236                 | 1/4                    | 0.796            | 0.787                | 0.805                 |
|       | 0.313                 | 5/16                   | 0.792            | 0.782                | 0.810                 |
|       | 0.365                 | 3/8                    | 0.794            | 0.781                | 0.801                 |
|       | 0.49                  | 1/2                    | 0.774            | 0.773                | 0.801                 |
| PYREX | 0.270                 | 1/4                    | N/A              | 0.805                | 0.792                 |
| PYREX | 0.373                 | 3/8                    | N/A              | 0.809                | 0.834                 |
| PYREX | 0.194                 | 3/16                   | N/A              | 0.802                | 0.814                 |

QA/QC CHECKLIST  
PRETEST PREPARATIONPROJECT NO. 1007-3 CLIENT CTI/TOWNE

1. Do you have a copy of the budget? Yes  
 2. Do you have a copy of the proposal? Yes  
 3. Do you understand the scope of work to be performed? Yes  
 4. Do you have a copy of the field work transfer sheets? Yes  
 5. The sampling systems to be used on this project are:

|             |          |                  |          |
|-------------|----------|------------------|----------|
| Particulate | <u>—</u> | MM5              | <u>—</u> |
| Metals      | <u>—</u> | VOST             | <u>—</u> |
| Rader       | <u>—</u> | Continuous Gases | <u>✓</u> |
| Fyrites     | <u>—</u> | Other            | <u>—</u> |

6. Do you have copies of the appropriate sampling methodologies?

7. Do you have copies of the following:

|                                  |            |            |             |
|----------------------------------|------------|------------|-------------|
| M5/Metals/MM5 QA/QC checklist    | Y <u>—</u> | N <u>—</u> | NA <u>✓</u> |
| VOST QA/QC checklist             | Y <u>—</u> | N <u>—</u> | NA <u>✓</u> |
| Rader QA/QC checklist            | Y <u>—</u> | N <u>—</u> | NA <u>✓</u> |
| Continuous gases QA/QC checklist | Y <u>✓</u> | N <u>—</u> | NA <u>—</u> |
| Field sheets                     | Y <u>✓</u> | N <u>—</u> | NA <u>—</u> |
| Recent calibration factors       | Y <u>✓</u> | N <u>—</u> | NA <u>—</u> |
| Chain of custody sheets          | Y <u>—</u> | N <u>—</u> | NA <u>✓</u> |
| Extra charges summary sheets     | Y <u>—</u> | N <u>—</u> | NA <u>✓</u> |
| Blue book                        | Y <u>✓</u> | N <u>—</u> | NA <u>—</u> |
| Field Work Transfer Sheet        | Y <u>✓</u> | N <u>—</u> | NA <u>—</u> |
| Pollution Control Data           | Y <u>—</u> | N <u>—</u> | NA <u>✓</u> |
| Summary Sheet                    | Y <u>✓</u> | N <u>—</u> | NA <u>—</u> |

8. Is the sampling equipment functioning properly (before it's taken into the field)? Examples:

|                     |          |                      |          |
|---------------------|----------|----------------------|----------|
| probe temp. ind.    | <u>—</u> | oven temp. indicator | <u>—</u> |
| stack temp. ind.    | <u>—</u> | probe heat ind.      | <u>—</u> |
| probe heat          | <u>✓</u> | oven heat            | <u>—</u> |
| magnehelics         | <u>✓</u> | pumps                | <u>✓</u> |
| strip chart record. | <u>✓</u> | gas analyzers        | <u>✓</u> |
| leak checks         | <u>✓</u> | other                | <u>—</u> |

9. Have the following been cleaned, proofed, weighed, prepared according to the appropriate sampling methodologies:

|                                    |          |
|------------------------------------|----------|
| sample jars and lids               | <u>—</u> |
| glassware                          | <u>—</u> |
| filters                            | <u>—</u> |
| liners/probes                      | <u>✓</u> |
| nozzles                            | <u>—</u> |
| wash bottles                       | <u>—</u> |
| probe brushes                      | <u>—</u> |
| sample capturing/rinsing solutions | <u>—</u> |
| other                              | <u>—</u> |

AIR TESTING SERVICES

PAGE 2 OF 2

QA/QC CHECKLIST  
PRETEST PREPARATION

10. Has the client been called to check?

scope of work  
test objective  
test schedule  
sampling site conditions  
port conditions  
process conditions  
accomadations

✓  
✓  
✓  
✓  
✓  
✓  
N.t

Name JOHN LEONARDE

Signature John Leonard

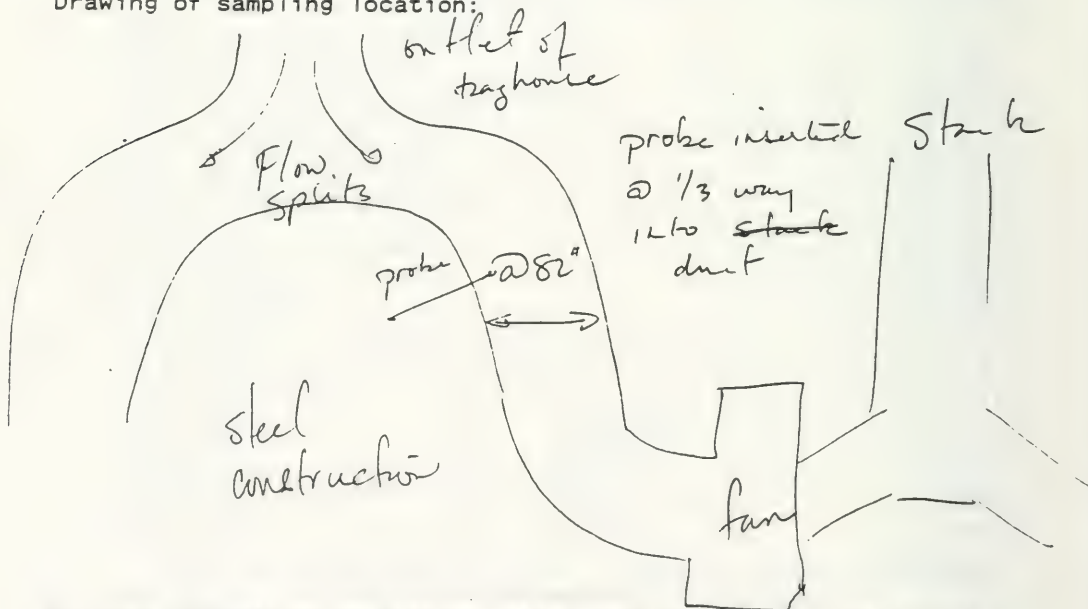


# AIR TESTING SERVICES

## QA/QC CHECKLIST GENERAL SAMPLING SITE

Project # 1007-3 Client CTI / DONOLLI Test(s) 3-1  
 Test Date JULY 3/91 Sample Location OUTLET OF BAGHOUSE BEFORE FAN  
 Stack duct cross section dimensions Ø 82"  
 equivalent diameter —  
 Material of construction steel  
 Internal appearance corroded? unavailable  
 caked particulate —  
 thickness —  
 Insulation? — thickness — lining? — thickness —  
 Nipple? — ID — length — flush with inside wall —  
 Straight run before ports? no diameters —  
 Straight run after ports? no diameters —  
 Photos taken? no of what —

Drawing of sampling location:



Minimum information on drawing: stack/duct dimensions, location and description of major disturbances and all minor disturbances (dampers, emission control devices, etc.) and cross sectional view showing dimensions and port locations.

John - P. [Signature]  
Signature

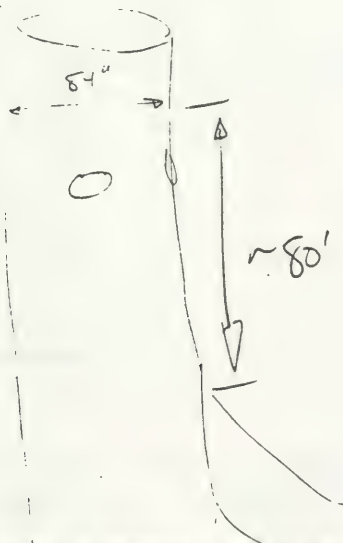
July 3/91  
Date

# AIR TESTING SERVICES

## QA/QC CHECKLIST GENERAL SAMPLING SITE

Project # 1007-3 Client CTT / HONOLULU Test(s) 3-1  
 Test Date July 3/91 Sample Location main stack  
 Stack duct cross section dimensions 84"  
 equivalent diameter \_\_\_\_\_  
 Material of construction steel (galvanized)  
 Internal appearance corroded? No  
 caked particulate No  
 thickness \_\_\_\_\_  
 Insulation? \_\_\_\_\_ thickness \_\_\_\_\_ lining? \_\_\_\_\_ thickness \_\_\_\_\_  
 Nipple? ✓ ID 4" length 3" flush with inside wall yes  
 Straight run before ports? yes diameters \_\_\_\_\_  
 Straight run after ports? yes diameters \_\_\_\_\_  
 Photos taken? no of what \_\_\_\_\_

Drawing of sampling location:



Minimum information on drawing: stack/duct dimensions, location and description of major disturbances and all minor disturbances (dampers, emission control devices, etc.) and cross sectional view showing dimensions and port locations.

John L. Lennan  
Signature

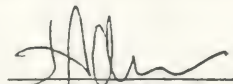
July 3  
Date

# AIR TESTING SERVICES

## QA/QC Checklist Continuous Emission Monitoring

Project #: 1107 Client: Tenneco Test: 3-1  
 Date: July 3/91 Time Start: 8:20 End: 5:15  
 Performed by: Jeff Adams Sample Location: MAIN STAIR (BANKHOUSE exit)

|             |                                  |                        |  |  |  |  |
|-------------|----------------------------------|------------------------|--|--|--|--|
| Parameter   | Monitored                        | SO <sub>2</sub>        |  |  |  |  |
| Instrument  | Make                             | WESTGEO Research       |  |  |  |  |
|             | Model                            | 721-AT                 |  |  |  |  |
|             | Range                            | —                      |  |  |  |  |
|             | Attenuation                      | —                      |  |  |  |  |
|             | Zero Setting                     | 736                    |  |  |  |  |
|             | Span Setting                     | 8.16                   |  |  |  |  |
| Cal gas     | Zero Gas                         | ✓                      |  |  |  |  |
|             | Span Gas                         | 100ppm SO <sub>2</sub> |  |  |  |  |
|             | Concentration                    | 100ppm = 2             |  |  |  |  |
|             | Cylinder #                       | Ex 17320               |  |  |  |  |
| Calibration | Zero (A.M.)                      | 0                      |  |  |  |  |
|             | Zero (P.M.)                      | 0                      |  |  |  |  |
|             | Span (A.M.)                      | 104                    |  |  |  |  |
|             | Span (P.M.)                      | 106                    |  |  |  |  |
| Recorder    | Type                             | HP                     |  |  |  |  |
|             | Full Scale (volt)                | 500.mV                 |  |  |  |  |
|             | Chart Speed                      | .1/min                 |  |  |  |  |
| Recovery    | Response direct to instrument    | Pass                   |  |  |  |  |
|             | Response Observed through system | 1 min                  |  |  |  |  |
|             | Observed loss %                  | —                      |  |  |  |  |
| Drift       | Pre-test span value              | 21 Div.                |  |  |  |  |
|             | Post-test span value             | 21 Div.                |  |  |  |  |
|             | Difference %                     | —                      |  |  |  |  |

  
 Signature

Jul 03/91  
 Date

# AIR TESTING SERVICES

## QA/QC CHECKLIST POSTTEST

PROJECT # 1007-3

CLIENT CTI / POWELL

1. Was the scope of work performed to completion? Yes  
If not, note deletions or additions made to scope of work.
2. Were field samples recovered according to appropriate methodologies? NA. If not, note differences.
3. Are the following items fully completed?

|                                               |                                       |                            |                                        |
|-----------------------------------------------|---------------------------------------|----------------------------|----------------------------------------|
| QA/QC checklists                              | Y <input checked="" type="checkbox"/> | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
| Isotrain sheets                               | Y <input type="checkbox"/>            | N <input type="checkbox"/> | NA <input checked="" type="checkbox"/> |
| Velocity sheets                               | Y <input checked="" type="checkbox"/> | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
| Front sheets                                  | Y <input checked="" type="checkbox"/> | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
| Rader sheets                                  | Y <input type="checkbox"/>            | N <input type="checkbox"/> | NA <input checked="" type="checkbox"/> |
| Vost sheets                                   | Y <input type="checkbox"/>            | N <input type="checkbox"/> | NA <input checked="" type="checkbox"/> |
| Cont.Emission monitoring sheets               | Y <input checked="" type="checkbox"/> | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
| Sample labels                                 | Y <input checked="" type="checkbox"/> | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
| Blue book                                     | Y <input type="checkbox"/>            | N <input type="checkbox"/> | NA <input checked="" type="checkbox"/> |
| Chain of Custody sheets                       | Y <input type="checkbox"/>            | N <input type="checkbox"/> | NA <input checked="" type="checkbox"/> |
| Extra charges summary sheet                   | Y <input type="checkbox"/>            | N <input type="checkbox"/> | NA <input checked="" type="checkbox"/> |
| Stripcharts                                   | Y <input type="checkbox"/>            | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
| Pollution control data sheets/Process Dscrptn | Y <input checked="" type="checkbox"/> | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
| Other field sheets                            | Y <input checked="" type="checkbox"/> | N <input type="checkbox"/> | NA <input type="checkbox"/>            |
4. Are all sample jars tightly sealed and stored in appropriate storage containers under appropriate storage conditions?
5. Are all sample filters in sealed petri dishes and stored in appropriate containers under appropriate storage conditions?  
Y ☐ N ☐ NA ☒
6. Do you have copies of all relevant process data? Y ☒ N ☐ NA ☐
7. Is the field data recorded clearly and concisely? Y ☒ N ☐ NA ☐
8. Has the field data been put in the project file in an organized matter? Y ☒ N ☐ NA ☐
9. Print name of field recovery sample custodian.

John Lennartz  
Name

John Lennartz  
Signature







